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No. 88

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MATERIALS SCIENCE AND METALLURGY

No. 88

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TITANIUM

WELDING

MISCELLANEOUS

UDC: 620.18:620.17:669.17'74

STRUCTURE AND PROPERTIES OF Al-Mn ALLOYS QUENCHED FROM LIQUID STATE

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 82 pp 46-48

FEDOROV, V. M. and LEBEDEVA, T. I., All-Union Institute of Light Alloys

[Abstract] Al-Mn alloys were used in a study of the influence of increasing the cooling rate to 10^5°C/sec on the structure and properties of granules and pressed bars obtained under industrial conditions. Increasing the cooling rate to 10^5°C/sec resulted in the production of anomalously supersaturated solid solutions of manganese in aluminum containing up to 6.7% Mn in granules 300 to 600 μm in diameter. The dendritic cell size decreased to 2-4 μm. Some 100- to 200-μm-diameter granules also contain primary branched dendrite intermetallides. In 300 to 500-μm-diameter granules a significantly more supersaturated solid manganese-in-aluminum solution was obtained than in 1000-μm granules. Further increasing the saturation of the solid solution yielded an additional hardening effect upon decomposition of the solution and an increase in the strength properties of semifinished goods at room temperature and higher. Figures 3; references 6: all Russian. [37-6508]

UDC: 621.785.78:669.715

VARIATION IN STRUCTURE AND PROPERTIES UPON MULTISTAGE AGING OF V95 ALUMINUM ALLOY SLABS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 82 pp 49-52

FRIDLYANDER, I. N., SANDLER, V. S., BOROVSKIY, S. N. and VLASKINA, I. I.

[Abstract] Results are presented from studies of the kinetics of variation in mechanical properties, corrosion resistance, electric resistivity and structure during two-stage aging of forged plates 70 mm thick of V95 alloy.

Three types of hardening were tested: 1) hardening of a 250 x 200 x 70 mm template in water at 50°C; 2) hardening of 200 specimens in a group in water at 50°C; 3) hardening of a small group (about 50 specimens) in water at 20°C. Specimens were aged at 120°C 3 hours, then at 165 or 175°C for up to 40 hours. The core of the specimens was found to be stronger than the outer portion. The strength of core and outer portion were therefore considered separately. Two-stage aging increased the yield point by not over 9 to 12% (method II) or 15 to 20% (method III) in comparison to method I but changed corrosion characteristics by at least 85 and 100%. Decreasing the quenching speed decreases the ultimate strength and yield point by 20 to 30 MPa and allows the aging time to be decreased by about 2 hours. Corrosion and resistivity remain unchanged. When aging time is increased the nature of corrosion changes. Most fragment boundaries are corroded, rather than primarily those oriented in the direction of rolling, as in the case with shorter aging. Figures 4; references 4: 3 Russian, 1 Western.
[37-6508]

UDC: 620.22.41

INTERACTION OF CARBON FIBERS WITH ALUMINUM ALLOYS CONTAINING ZIRCONIUM

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 82 (manuscript received 20 Jan 82) pp 119-120

UTEPOV, E. K., KOSTIKOV, V. I. and VARENKOV, A. N., Moscow

[Abstract] One condition improving the bond between a metal matrix and fiber in a composite is wetting of the fiber by the metal melt. The wettability of graphite materials by an aluminum melt can be improved by adding carbide forming elements such as titanium. This work studies the influence of zirconium, a group IVA carbide forming metal, on this characteristic. The kinetics of processes of formation of a transitional ZrC layer was studied. The width of the transient zone between the matrix metal and fiber was measured by microscopic examination. It is concluded that a solid ZrC coating is formed on the surface of the graphite fibers. Figures 1; references 6: all Russian.
[32-6508]

UDC: 669.14:539

FRACTURE TOUGHNESS OF Al-Mg-Si ALLOYS UNDER CYCLIC AND STATIC LOADING

Kiev PROBLEMY PROCHNOSTI in Russian No 11, Nov 82
(manuscript received 26 Jun 80) pp 16-19

KUDRYASHOV, V. G., SHTOVBA, Yu. K., All-Union Institute of Light Alloys, Moscow

[Abstract] The values of static fracture toughness and cyclic fracture toughness are compared for the AVpch, AD33 and AD35 medium strength aluminum alloys. The cyclic toughness values were determined with various coefficients of load cycle asymmetry. The variation of static toughness as a function of the direction in which the specimens are cut indicates that toughness decreases in a sequence typical for pressed and rolled aluminum alloy products. The degree of variation in fracture toughness in different orientations is explained by analysis of the microstructure, which is greatly extended grains in the pressing direction. The cyclical toughness varied with loading cycle asymmetry, decreasing with increasing asymmetry. Figures 3; references 6: 5 Russian, 1 Western.
[45-6508]

SELECTION OF BINDERS FOR LASER SURFACING WITH WEAR RESISTANT CHROME-BORON-NICKEL POWDERS

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 5, Sep-Oct 82 (manuscript received 9 Oct 81) pp 33-37

GRIGOR'YANTS, A. G., SAFONOV, A. N. and SHIBAYEV, V. V., Moscow

[Abstract] The purpose of this work was to develop a method of producing wear resistant coatings by melting of a powder mixture prepared with binder substances by the radiation of a continuous CO_2 laser. The studies performed make it possible to analyze the process of formation of surfacing metal wear-resistant coatings upon laser working of powder mixtures prepared for various binder substances. The optimal binder substances are nitrocellulose varnishes with a low dry residue, since their gaseous combustion products are easily removed from the area of laser interaction without preventing the formation of a liquid surfacing metal bath. Figures 3; references 4: 2 Russian, 2 Western.
[34-6508]

UDC: 539.3+539.4

ELASTIC-PLASTIC BEHAVIOR OF LAYER-FIBER MATERIAL

Kiev PROBLEMY PROCHNOSTI in Russian No 10, Oct 82
(manuscript received 10 Dec 81) pp 96-102

BAGMUTOV, V. P., Vologograd Polytechnical Institute

[Abstract] An earlier work derived the physical relationships between stresses and strains for a reinforced medium in the elastic deformation area by the method of layer separation of the structure and subsequent decomposition of the complex body stress state into groups of 1 or 2 non-zero stresses. Using this method, the author studied the elastic-plastic behavior and the strength of a layer-fiber composite, taking into account temperature effects. It was assumed that generally each layer of the composite is a multicomponent composite itself consisting of alternating parallel structural elements. Successive application of the base model in the form of a layered packet of unit dimensions with arbitrary layer anisotropy for each layer and the composite as a whole allowed determination of the system of thermoelastic, plastic and strength characteristics of the material required. Generally the actual cross section of the fiber is replaced by a model rectangle, the dimensions of which are found by taking into account the intensity of reinforcement of the composite both through the thickness of the material and in the plane of each layer. Figures 4; references 9: all Russian.
[38-6508]

UDC: 669.018.6:661.882.621:537.311.33

RESISTIVITY OF HOT PRESSED TiC-SiC-C COMPOSITES

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 82
(manuscript received 7 Sep 81) pp 44-49

GORINSKIY, S. G., BEKETOV, A. R., SHABALIN, I. L., PODKOVYRKIN, M. I. and KOKORIN, A. F., Urals Polytechnical Institute

[Abstract] A study was made of the resistivity of TiC-SiC-C obtained by hot pressing at 2700 to 3000°K and 12 MPa. Specimens were held at maximum temperature 15 minutes. The resistivity of specimens cut perpendicular to the pressing axis was measured at room temperature, that of specimens cut parallel to the axis at 300 to 2000°K. Experimental results were converted to the pore-free state by an equation. Contour curves of the response surface of resistivity are presented. It is found that the influence of the carbon phase is manifested as anisotropy of resistivity and as the presence of a bend point on the curve of resistivity as a function of temperature in the 900 to 1200°K interval. Introduction of silicon carbide results in a significant increase in resistivity. High silicon carbide content results in inhibition of the process of decreasing the fraction of titanium carbide when free carbon is present. This is manifested as an ambiguous variation of resistivity as a function of concentration. Figures 4; references 9: all Russian.
[43-6508]

UDC: 669.721:620.193:539.4.01

INFLUENCE OF LIQUID MEDIA ON STRENGTH OF COMPOSITE WITH ALUMINUM MATRIX

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 18, No 5, Sep-Oct 82 (manuscript received 29 Jun 81) pp 35-38

YATSENKO, M. I. and VASILENKO, A. G., Institute of Mechanics, Ukrainian Academy of Sciences, Kiev

[Abstract] Results are presented from a study of the influence of liquids on the anisotropy of the strength of unidirectional sheet boroaluminum in extension. The material was obtained by hot rolling. The volumetric content of fibers in the composite was 25 to 35%. Specimens were cut from the sheet material on an electric spark machine. The angle between the direction of the tensile load and fiber axis was 0, 5, 10, 15, 30, 60 and 90°. Specimens were degreased and the ends covered with a protective varnish. After holding in TS-1 aviation fuel, water and 3% NaCl for 4000 hours, they were tensile tested, the results determined by averaging 5 to 7 experiments. It was found that aviation fuel has practically no influence on composite material strength. Water causes slight corrosion damage to individual areas of the

specimens and a slight decrease in strength. The NaCl solution causes a decrease of 5 to 12% at 0 to 15° and up to 20% at over 15° angle. This medium also causes severe blister and delaminating corrosion of almost the entire surface of the specimen. Penetration depth of corrosion products into the surface layers of the matrix is about 2 μm. Figures 2; references 5: all Russian.
[40-6508]

UDC: 678.067.5

EXPERIMENTAL STUDY OF STRENGTH OF GRP WITH LONGITUDINAL-TRANSVERSE REINFORCEMENT IN PLANAR STRESS STATE

Kiev PROBLEMY PROCHNOSTI in Russian No 11, Nov 82
(manuscript received 16 Jun 81) pp 100-106

KULIC, V. I., MESHKOV, Ye. V., RIKARDS, R. B., UPITIS, Z. T.,
Leningrad Institute of Mechanics, Institute of Polymer Mechanics,
Latvian Academy of Sciences, Leningrad, Riga

[Abstract] Results are presented from an experimental study of the strength surface of glass-reinforced plastic with longitudinal and transverse reinforcement in a planar stress state and the possibility is estimated of using various fracture criteria for this type of composite. Experiments were performed on thinwall tubular specimens manufactured by longitudinal and transverse winding of presaturated unidirectional glass fiber tape produced by soaking VMS-6 glass fiber in EDT-10 epoxy binder and subsequent drying. The percent content of binder in cured specimens was 25±2% by weight. The strength of the tubular specimens was studied under short-term loading on an MTS testing machine with programmed control in axial extension and compression, torsion, internal hydrostatic pressure and various combinations. Equations for the fracture criteria are presented. The best approximation of the test results was achieved by optimizing all experimental data with equation (9). Values of surface strength tensor components described by this equation allow the Muhlmeister criterion to be used in the design of structures of this type of GRP. Figures 4; references 8: all Russian.
[45-6508]

UDC: 539.25:669.018.95

FRACTOGRAPHY OF FIBER COMPOSITES

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 82 (manuscript received 9 Dec 80) pp 103-108

LEKSOVSKIY, A. M. and ABDUMANONOV, A., Leningrad

[Abstract] The fracture surfaces of a composite are sutdied for various test temperatures and stresses to produce information on the specifics of composite fracture as a function of static or cyclic loading conditions. The composites consisted of a matrix of D16 aluminum alloy with boron, tungsten and tantalum fiber reinforcement. The fracture surfaces were studied with a JSM-15 scanning electron microscope. It was found that as the volumetric fraction of boron fibers was increased from 30-35 to 60-65%. This is because with decreasing fiber separation the probability of acoustical influence of fracture of one fiber on its neighbor increases. It is assumed that the slow stage of fracture is the process of separation of fibers from the matrix. Brittle jackets around the fibers significantly reduce the mechanical strength for both short-term and cyclical loadings but apparently have little influence on strength properties under long-term static loading. Figures 5; references 11: 10 Russian, 1 Western.
[32-6508]

UDC: 620.18:678.067

STUDY OF STRESS-STRAIN STATE OF DISPERSELY REINFORCED COMPOSITE MATERIALS BY SPECKLE HOLOGRAPHIC INTERFEROMETRY

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 5, Sep-Oct 82 (manuscript received 23 Feb 82) pp 941-944

KONONENKO, V. G., RASSOKHA, A. A., KOBRIN, V. N. and GRECHKA, V. D., Kharkov Aviation Institute imeni N. Ye. Zhukovskiy

[Abstract] The purpose of this work was to determine the deformations and stresses in dispersely reinforced basalt-polymer materials (basalt-reinforced plastic) by speckle holographic interferometry. Studies were performed on specimens of rectangular shape measuring 120 x 80 x 25 mm containing fragments of heat treated basalt (5 to 20 mm fraction) and an epoxy-organo-silicon resin type VFM-135 with curing agent. All faces of the specimens were polished. The basalt reinforced plastic is a thermally stressed material with high and nonuniform thermal stresses which may be dangerous if the temperature changes greatly, leading to cracking of the matrix, particularly in the areas where basalt particles come close together, near acute angles of particles and at the matrix-filler interface. The stress-strain state of a given area in the material is determined not

only by the mean stress and local elasticity constants, but also by the stress-strain state in neighboring areas, fluctuations and geometric parameters and the location of the reinforcing basalt particles.
Figures 4; references 5: all Russian.
[36-6508]

UDC: 539.377:678

COMPLIANCE OF UNIDIRECTIONALLY REINFORCED INELASTIC MATERIAL

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 5, Sep-Oct 82
(manuscript received 2 Dec 81) pp 784-788

KARUMBAYEV, T. D., Moscow

[Abstract] An attempt is made to construct the function $\varepsilon = f(\sigma)$ for a unidirectionally reinforced material based on experimentally established deformation curves for each of the components of the composite. The resistance of the material is linear up to the point at which one of the components begins plastic deformation. The determining characteristics of the compoiste in the direction orthogonal to the fibers are the properties of the matrix materials. Maximum fiber elongation influences the total deformation capacity of the compoiste. Nonlinear physical relationships are constructed between deformation and stress for a transversely isotropic body. Analytically constructed curves of deformation of a transversely isotropic body agree qualitatively with experimental results. Figures 2; references 12: 11 Russian, 1 Western.
[36-6508]

UDC: 621.791:061.43(47+57)

ALL-UNION CONFERENCE ON WELDING OF DISSIMILAR, COMPOSITE AND MULTILAYER MATERIALS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 82 pp 77-78

KIRPATYY, V. A., engineer

[Abstract] In accordance with a resolution of the Coordination Council for Welding at the Institute of Electric Welding imeni Ye. O. Paton, the 8th All-Union Conference on welding of dissimilar, composite and multilayer materials was held in Kiev 16-18 Feb 1982. Over 300 persons from 58 cities in the USSR took part in the conference. Academician B. Ye. Paton opened the conference, emphasizing that the problem of welding of dissimilar metals continue to be pressing in many branches of industry. Reports at the conference covered topics such as: creation of scientific foundations and technologies for welding by rolling, pressing, stamping and diffusion welding of sheets, plates, pressed panels, pipe, etc.; the use of layered and dissimilar metals; development of original methods for vapor static pressing; theoretical problems of the production of multilayer sheets with various ratios of hard and soft components; problems of explosive welding of dissimilar difficult-to-weld materials; the influence of mechanical heterogeneity on the stress-strain state and mechanical properties of welded joints in dissimilar materials in the elastic and elastic-plastic stages; diffusion welding of dissimilar composite and multilayer metals; the structure and properties of multilayer titanium alloy blanks made by diffusion welding; the corrosion resistance of welded joints of titanium and steel; joining of copper alloys with steels; welding and surfacing; calculation of temperature fields in steel-aluminum joints 40 mm thick; a new high speed method of pressure welding - vacuum impact welding; and the welding of refractory metals with other metals.
[33-6508]

UDC: 535.21:621.9.048

INFLUENCE OF FLUIDITY ON METAL FRACTURE BY LASER RADIATION

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 82 (manuscript received 18 Nov 80) pp 5-10

AGEYEV, V. A., Vitebsk

[Abstract] The regularities of light erosion of metals in air and in distilled water are compared and the explosive process caused by the liberation of laser radiation energy on the surface of metal and removal of the products in liquid are studied. The experimental installation included a laser operating at 1.06 μm, 2.1 J, pulse length 900 μs with a quartz cuvette filled with water installed in the focal plane of a telescopic system. The diameter of the light spot on the target surface was not over 200 μm. The results of cinematic studies and piezoelectric measurements of pressure fields formed upon interaction of laser beam and metal surface in distilled water agreed satisfactorily with the values obtained using known hydrodynamic equations and indicate that the processes occurring during underwater explosions can be simulated by this means. Figures 4; references 6: all Russian. [32-6508]

UDC: 536.4

KINETICS OF METAL EVAPORATION INTO GAS ATMOSPHERE WITH KNOWN ENERGY FLUX

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 82 (manuscript received 19 Apr 82) pp 11-14

UGLOV, A. A. and GLUS'KOV, A. P., Moscow

[Abstract] The flat surface of a metal target in an atmosphere of an electrically neutral, chemically inert gas was irradiated by a fixed constant concentrated energy flux. Equations are derived to determine the variation in temperature of the target surface and gas dynamic and kinetic parameters of the vapor and gas at the target surface and at the boundary of the kinetic and gas dynamic areas with time. The kinetics of

evaporation of an iron target in an atmosphere of argon are studied. The kinetic model suggested in the authors' earlier works yields numerical results which agree with the experimental results. An increase in gas pressure leads to an increase in target surface temperature. The recoil pressure on the surface of the target increases with increasing surrounding gas pressure under steady evaporation conditions. Considering the shielding of the metal surface by the plasma, the mass carried away from the irradiated zone has a maximum at a certain gas atmosphere pressure. Figures 2; references 9: 8 Russian, 1 Western.
[32-6508]

UDC: 535.23

DEEP MODULATION OF CONCENTRATED ENERGY FLUX ACTING ON METAL SURFACE

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 6, Nov-Dec 82 (manuscript received 13 Jul 81) pp 29-31

UGLOV, A. A. and GUS'KOV, A. P., Moscow

[Abstract] Numerical experiments are analyzed in which the reaction of the response temperature of a metal surface and recoil pressure are analyzed in response to deep harmonic and pulsed modulation of a concentrated energy flux within the framework of the nonlinear thermal model of metal surface evaporation. With great modulation depth of the energy the phenomenon of thermal resonance is observed. At the points of the maximum response evaporative recoil pressure is 10 to 20% greater than the steady state pressure. Figures 2; references 7: 6 Russian, 1 Western.
[54-6508]

UDC: 669.10

PLASTIC DEFORMATION OF METAL FOILS EXPOSED TO LASER RADIATION

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 6, Nov-Dec 82 (manuscript received 19 Jan 82) pp 11-14

SAMOYLOVICH, S. S., PALEY, Yu. M., PAVLOV, V. V. and SHITOVA, N. V., Izhevsk

[Abstract] A study was made of the dislocation structure of FCC metals (aluminum and copper) with various packing defect energies after laser irradiation. The aluminum specimens were rolled to 100 μm and 50 μm thickness (98.6 and 98.9% purity). The foils were vacuum annealed (420°C for aluminum and 550°C for copper) for three hours to achieve equilibrium. Irradiation was performed with a GOR-100M laser, yielding pulses with energies up to 100 J

and pulse length 10^{-3}s. Microhardness was measured near the crater, in the cooled melt, at the melt boundary and in the initial material to determine the influence of the laser beam on degree of hardening and distribution of surface deformation. The physical spreading of the (311) x-ray line of the specimens established the overall level of hardening. The laser beam caused local heating to very high temperatures and deformation by thermal waves accompanied by structural changes. The size of the heated area and the degree of deformation are a function of the pulse energy and consequently of pumping voltage and focusing of the beam. The deformation mechanism also varies with metal packing defect energy. Figures 4; references 9: 8 Russian, 1 Western.
[54-6508]

UDC: 539.23:678.669

FORMATION AND GROWTH OF METAL FILMS ON POLYMER SURFACES IN VACUUM

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 6, Nov-Dec 82 (manuscript received 14 Jul 80) pp 52-55

ROGACHEV, A. V., Gomel'

[Abstract] A study is presented of the kinetics of metal film growth on the surfaces of polymers with various structures and chemical compositions, as well as the influence of polymer surface temperature and incident atomic flux intensity on kinetic parameters. The kinetics of metal film formation was studied on the surface of polymers by determining the condensation factor during precipitation and analysis of the status of the condensed film. The sensors measuring the reevaporated atom flux density were devices which measured the rate and thickness and precipitation of films as well as a mass spectrometer. The kinetics of metal atom precipitation onto surface of the polymer body was found to be unsteady, determined by conditions of the process and the nature of the interacting substances. When metal atoms precipitate on the surface of nonpolar polymers at temperatures near the glass point, condensation is interrupted. The temperature variation of condensation factor results from the differing nature of metal phase seed centers on the surface of nonpolar and polar polymers. Figures 3; references 9: all Russian.
[54-6508]

UDC: 535.211

NONLINEARITY OF LASER HEATING OF METALS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 267, No 2, Nov 82
(manuscript received 31 May 82) pp 377-381

RYKALIN, N. N., academician, UGLOV, A. A. and SMUROV, I. Yu., Institute of Metallurgy imeni A. A. Baykov, USSR Academy of Sciences, Moscow

[Abstract] In this study of the nonlinearities of laser heating of metals, all nonlinearities are simultaneously considered: absorptive capacity, heat conductivity coefficient and volumetric heat capacity. It is shown that the combined influence of nonlinearities in many cases leads to essentially new results. The heating of a semi-infinite body by a moving laser beam is studied. An algorithm is developed for approximate analytic solution of the equation system describing the problem. The algorithm successively considers the nonlinearities, reducing the solution of the nonlinear equation to solution of a system of linear heat conductivity equations. The results of calculation of the temperatures upon heating of molybdenum and tungsten by a nonmoving laser beam show that in the initial stage of heating the temperatures calculated in the nonlinear approximation agree with temperatures calculated for the initial values of absorptive capacity and thermophysical coefficients. As the temperature increases, the situation changes and it is impossible to select constant values of absorptive capacity and thermophysical properties such that the linear model describes the process of heating satisfactorily throughout the entire temperature range. Figures 3; references 6: all Russian.
[46-6508]

UDC: 539.415:539.1.04:669.296

INFLUENCE OF REACTOR IRRADIATION ON MECHANICAL PROPERTIES OF ZIRCONIUM ALLOYS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 6, Nov-Dec 82
(manuscript received 26 Mar 80) pp 3-7

TSYKANOV, V. A., SAMSONOV, B. V., ROGOZYANOV, A. Ya., LOSEV, N. P., SHAMARDIN, V. K., KOBYLYANSKIY, G. P., NIKULINA, A. V., FIVEYSKIY, M. B.

[Abstract] Zirconium alloys Zr+1% Nb, Zr+2.5% Nb and Zr+1% Nb with high oxygen content (up to 0.13%) were studied. The specimens were cut from fuel element tubing subjected to neutron bombardment in three reactors. The specimens were tested for strength by internal helium pressure, and for long-term stability by external helium pressure. In the first stage the effect of flux and bombardment temperature on short-term mechanical properties was studied. Radiation hardening was accompanied by a decrease in overall and uniform deformation. The second stage included experiments on the long-term

stability of the tubes and short-term testing of rings in transverse extension. It was found that the long-term stability of the specimens with 0.13% oxygen was greater than that of specimens with 0.08% oxygen following neutron bombardment at 350 and 450°C. At 350°C bombardment temperature the alloy with 1% Nb is hardened at a neutron flux density of over $5 \cdot 10^{13}$ neutrons per square centimeter per second. Figures 5; references 4: all Russian.
[54-6508]

FIRST DEPUTY MINISTER OF NONFERROUS METALLURGY DISCUSSES WASTE-FREE TECHNOLOGY

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 24 Dec 82 p 2

[Article by V. Boroday, USSR first deputy minister of nonferrous metallurgy: "All Our Mineral Wealth"]

[Text] The ministry recently received good news from the concentration mill at the Verkhnedneprovsk Mining and Metallurgical Combine. A process for obtaining five valuable concentrates -- ilmenite, rutile and others, as well as quartz molding sand -- has come on-line. This sand is considerably less expensive than that obtained at specialized enterprises and is even superior in quality.

Another step has been taken toward converting the mill over to no-waste technology. It would seem that everything being processed there will be utilized, with nothing left over. This has resulted in a substantial increase in the economic value of each ton of ore mined. The waste rock -- sand -- has also become a merchantable product. In addition, it is no longer necessary to build a new waste dump, and the acreage designated for this dump is being turned over to agriculture.

Beneficiation is a highly indicative process from the standpoint of comprehensive utilization of raw materials. This branch's concentration mill workers are presently turning out 60 different merchantable products, and almost one third of these involve utilization of former tailings. By-product pyrite, barite, magnetite and other concentrates have become a valuable raw material for associated branches of the economy.

One can scarcely exaggerate the importance of this work; it was discussed at a session of the USSR Supreme Soviet. It was emphasized that nonferrous metals production growth should proceed not only in the direction of increasing production of ore but also comprehensive processing of raw materials and further development of secondary nonferrous metallurgy.

We know that the economy's requirements in nonferrous metals, which are growing year by year, demand a continuous increase in ore production. This year the volume of mining operations in this branch will exceed 2.4 billion tons -- more than ever before. At the same time many years of intensive working of mineral deposits has led to exhaustion of the highest-grade and easiest-access sections of ore bodies. Mining operations have moved to considerable depths.

We are now proceeding with the exploitation of complex, multiple-constituent deposits and sections with low-grade, dispersed ores. In order to reduce losses it is necessary to take into account literally every single gram of raw ore.

What reserve potential do we have at our disposal? The first is expansion of the volume of surface mining of ore bodies, which produce the best ore extraction indices, and losses are minimal. In the last 20 years the percentage share of surface mining has increased from 44 to 65 percent of the total volume.

Technical and technological innovations have also come to underground mining operations. Considerable experience has been amassed in nonferrous metallurgy in the employment of underground mining systems involving filling mined-out cavities with hard-setting mixtures. The percentage share of these systems today exceeds one fourth of the total and is continuing to rise. Employment of these systems is making it possible substantially to increase the recovery of ore from the ground, particularly in conditions of substantial rock pressure at great depths.

Ore is being recovered efficiently at the Norilsk Mining and Metallurgical Combine, the Gay and Khrustalnenskiy Mining and Beneficiation combines, at the Sorsk Molybdenum Combine, and at many other enterprises. This is being fostered by the adoption of advanced mining technology, new equipment, and a well-organized geological-mine surveying service. At the present time nuclear-physics instrumentation is being used at one out of every three mines in this branch for testing ore samples and obtaining a quick analysis of ore grade right at the production face. More than half of our miners are working according to economically substantiated quota standards for recovering ore in mining operations.

This is not the situation everywhere, however. Delays are occurring in adopting advanced ore mining methods at the Tekeli Combine and at the Belousovka mine of the Irtyshsk Complex Ore Combine. Large losses of crude ore are occurring at the Dzhezkazgan Mining and Metallurgical Combine. Obviously experts at the Kazakh SSR Ministry of Nonferrous Metallurgy, headed by minister S. Takezhanov, must work persistently to correct existing deficiencies.

In order to solve urgent problems, our mining enterprises need mining equipment for selective (separate) mining: surface-mine hydraulic excavators and high-output single-bucket loaders. New types of transfer equipment are needed for moving ore and waste rock from deep pit mines, as well as operationally reliable drilling and loading-hauling equipment for underground mines. Not individual machines but a system of machinery is needed for fuller recovery of crude ore. Mintyazhmash [Ministry of Heavy and Transport Machine Building] is well aware of this, but the enterprises and institutes of this ministry and their counterparts in the Ministry of Construction, Road, and Municipal Machine Building have as yet failed to solve these problems.

And yet it is no secret that in mining scientific and technological advances should run ahead of the rate of worsening of mining-geologic conditions connected with moving to greater depths and commencing to exploit complex

structures. Only in this way can we ensure the fullest possible recovery of ore from the ground and comprehensive utilization of the raw material.

A decline in the grade of crude ore is an objective phenomenon. But to accept this complacently, simply to resign oneself means accepting increased losses. Therefore we have stated the task of achieving further increase in recovery of metals and of extraction of all secondary constituents from complex ores. This requires improving the traditional process of concentrating crude ore and developing new, more efficient methods and equipment.

Self-comminution processes prove quite effective. This method is currently being employed in processing diamond- and gold-containing ores. Tungsten-molybdenum ores are self-comminuted at the concentration mill at the Tyrnyauz Mining and Metallurgical Combine, and copper-zinc ores at the Nikolayevskaya mill at the East Kazakhstan Copper and Chemical Combine.

We are ready and willing to employ this process more extensively. But we are prevented from doing so by the equipment. The self-comminution mills made by the Syzran Turbine Engineering Plant generate many complaints. Their lining is not durable enough, while their reduction gears, screens, bearings, and stuffing-box seals fail frequently. The design of this equipment must be improved. And demand for this equipment is being far from satisfied.

We are placing high hopes on the employment of gravity and radiometric methods of preliminary concentration of ores at the satege of preparation for concentrating. This also produces considerable benefit. But at the present time radiometric classification and concentrating processes are developing quite slowly. We order radiometric equipment and luminescent separators made by the Soyuzanalitpribor All-Union Production Association of Minpribor [Ministry of Instrument Making, Automation Equipment and Control Systems], but we are not receiving the needed equipment. Our enterprises also need equipment for nuclear-physical ore grading at the mining and hauling stage. Incidentally, this type of ore grading, which has been adopted at several enterprises, generates annual savings in excess of 10 million rubles.

An important role in ensuring the comprehensive processing of low-grade and hard-to-concentrate crude ore is played by the development and adoption of new flotation reagents. We could name several highly effective preparations which have completed comprehensive testing and have been approved for manufacture. USSR Minkhimprom [Ministry of Chemical Industry], Minudobreniy [Ministry of Fertilizer Industry], and Minneftekhimprom [Ministry of Petroleum Refining and Petrochemical Industry], however, are not even scheduling their manufacture in the current five-year plan.

Our arguments are also being ignored by USSR Gosplan's chemical industry department, headed by M. Vasil'yev. His colleagues unfortunately either are unable or unwilling to comprehend the great importance of these reagents for nonferrous metallurgy, and yet experts have calculated that their adoption will eliminate losses of almost 14,000 tons of nonferrous and rare metals each year!

Resource-conserving technologies also include so-called autogenous and hydrometallurgical processes. Their adoption makes it possible to come very close to solving one of the most important problems in nonferrous metallurgy -- development of no-waste and low-waste production operations. The hydrometallurgical method of processing crude ore, adopted at the Chelyabinsk Electrolytic Zinc Plant, makes it possible to recover zinc, copper, cadmium, other metals, as well as sulfur almost totally from crude ore. After roasting, sulfur containing gases are used to produce sulfuric acid. Solid waste materials -- lead cake and clinker -- are processed at related enterprises.

The new technology virtually eliminates water and air pollution. Dump slags are delivered in their entirety to construction organizations. Comprehensive processing of raw nepheline at the Pikalevo Glinozem Association and the Volkhov Aluminum Plant involves a completely closed water use cycle and production of by-products -- soda, potash, and portland cement.

As practical experience convinces us, an uncompromising campaign against losses of nonferrous metals, crude ore, energy resources and other materials involved in their processing will generate actual savings through the entire production chain from the mine to shipping of finished products to the customer only when plans are bolstered by strong, daily organizational and technical efforts.

Considerable work is being done at the USSR Ministry of Nonferrous Metallurgy in this direction. But the problem has long since grown beyond the framework of a single ministry. It is high time to unify the efforts of experts in nonferrous metallurgy and related branches -- the people in machine building, chemicals, and instrument engineering -- all those on whom scientific and technological advance depends in matters of comprehensive processing of crude ore and utilization of all its constituents in the nation's economy. The decisions of the November (1982) CPSU Central Committee Plenum demand precisely this.

3024
CSO: 1842/50

RICH NONFERROUS METALS DEPOSITS DISCOVERED IN CHITA OBLAST

Moscow SOVETSKAYA ROSSIYA in Russian 2 Nov 82 p 1

[Article by ZABAYKAL'SKIY RABOCHIY correspondent G. Vasilyuk, Chita: "Mineral Deposit... in Tailings"]

[Text] Two rich nonferrous metals deposits were discovered in the southern part of Chita Oblast. Initially tungsten was discovered, and subsequently tantalum. The Orlovskiy Mining and Beneficiation Combine, named in honor of Vadim Orlov, the geologist who discovered the deposits, was built adjacent to these ore bodies.

There are now dumps adjacent to the concentration mill, where so-called "waste materials" are stored. The miners call them "concentration tailings." What do these dumps contain? Primarily tungsten and tantalum, which cannot be fully recovered from the ore due to deficiencies in process and equipment. Obviously this is not good, but essentially the problem is solvable. If the appropriate technology is developed, this metal can be extracted with secondary processing.

A quite different matter is the waste products of basic production which could be effectively processed right now. Essentially there should be virtually no "tailings" at this enterprise. First-class crushed rock can be produced even from gangue, and crushed rock is in acute demand with construction people, road builders, and the transport industry.

A good management approach by the local miners also suggested other economically rational solutions. At their own initiative, the combine's workers endeavored to set up production of foamglass -- a lightweight and attractive insulating material -- from waste materials. A design institute prepared documentation for an experimental plant with an annual output capacity of 31,000 cubic meters of product. Unfortunately things progressed no further than this. The USSR Ministry of Nonferrous Metallurgy failed to allocate money for building the plant. The documents went into the inactive files, and the several tens of thousands of rubles spent on their preparation were written off as a loss. And today foamglass, which is so needed by the economy, can be seen only on the shelves at the enterprise museum.

Incidentally, this setback did not dishearten the combine's technologists and engineers. Over a period of several years they displayed enviable persistence

in endeavors to set up production of industrial mica. They were more successful in this endeavor. Presently the pioneer facility -- the old concentration mill -- is producing hundreds of tons of highly valuable raw material for the electrical equipment industry and the paint and varnish industry. There is enormous demand for this product, but for the time being the capabilities of the Orlovskiy Combine are limited. All hopes are placed on startup of a new, larger-capacity concentration mill. The question is -- will these hopes be realized?

The newspaper ZABAYKAL'SKIY RABOCHIY has on numerous occasions published materials dealing with the comprehensive utilization of the riches of the Orlovskiy mineral deposit. Recently it carried a feature article entitled "Ministerial Tub."

The newspaper's critical article prompted a reply by First Deputy Minister V. Boroday. In particular, he stated the following: "Production of quartz-feldspar products (crushed rock) is not scheduled at this stage, since the Irgiredmet Institute has not yet completed its research for developing a process for obtaining these products. The Chitageologiya Association is surveying crushed rock reserves in stripping operations. Upon its completion the ministry will consider the possibility of large-scale production of crushed rock and construction of a rail branch line running from Orlovskiy to Mogoytuy."

The uninitiated person might form the impression that the Soyuzvol'fram Main Administration and the Ministry of Nonferrous Metallurgy itself are very concerned over the problems of the people at the Orlovskiy Mining and Beneficiation Combine and are very much in favor of producing crushed rock, which will make the enterprise operate at a profit, that they are in favor of industrial mica, which is in such great demand, and in favor of a rail branch line, construction of which would be repaid in 6 months.

In the opinion of the experts at Chitageologiya, however, this reply casts a "shadow on the fence," for it is not particularly time-consuming to make crushed rock production calculations. They are known to the combine's geological service; they are not difficult to calculate -- and they have already been calculated.

The question of building a branch rail line has been under discussion for 5 years now, but instead of a concrete decision the ministry only makes vague promises. Incidentally, we should also note that the Ministry of Nonferrous Metallurgy also has an extremely one-sided attitude toward the fate of the principal metals in the Orlovskiy ore body. They are willing to spend money on construction of industrial facilities. They built a new concentration mill, although with considerable delay, and its startup is scheduled. Now, however, the management of the mining and beneficiation combine is faced with another acute problem: who is going to bring the new production facilities on-line?

This outcome was foreseen long ago, since construction of housing, sociocultural and services facilities was being conducted disproportionately to industrial construction. The ministry simply allocated meager amounts for these purposes. In the last 2 years the miners have received about a hundred apartment units, while the list of persons needing housing is three times as much.

We are on the threshold of another fiscal year, but we can see no prospects for further development of the worker community. There are as yet no plans for its second unit. We do not know how much will be allocated for housing, sociocultural and services facilities. You cannot hire workers without housing, and without personnel there will be no increased production of ore and recovery of metals. Just what does the Ministry of Nonferrous Metallurgy want to have in this situation: a steadily and profitably operating combine, or an enterprise with facilities which are not yet on-line?

The Orlovskiy Mining and Beneficiation Combine possesses considerable capabilities to expand its production volume. Obvious disproportions, however, have now developed in the growth of this enterprise. The primary question is how the riches of this mineral deposit can be utilized in a comprehensive manner, and how can we speed up development of the social infrastructure?

3024
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METALLURGISTS COOPERATE

Moscow DAILY REVIEW in English Vol 28, No 23, 10 Dec 82 pp 1-5

[Article by P. F. Lomako, Minister of Nonferrous Metallurgy of the USSR]

[Text] During several decades the USSR has been cooperating in nonferrous metallurgy with other countries. Soviet specialists take part in designing, building, putting into operation and maintaining nonferrous metallurgy projects abroad. Technical documentation worked out by us for foreign projects, Soviet equipment made and delivered for these enterprises and Soviet specialists' skills are highly rated by foreign customers. As of the beginning of 1982 more than 100 enterprises and individual projects of nonferrous metallurgy had been built with Soviet economic and technical assistance, including 58 ore extraction and dressing enterprises and 40 enterprises producing nonferrous metals.

Some of these products are delivered to the Soviet Union as compensation for assistance on a commercial basis. We also appraise highly the participation of foreign companies, research institutions and experts in constructing nonferrous metallurgy projects on Soviet territory.

Fruitful Cooperation

The USSR's nonferrous metallurgy has accumulated vast experience of cooperation with CEMA member countries. It is maintained both on a bilateral and multilateral basis within the framework of the CEMA Standing Commission on Cooperation in the Field of Nonferrous Metallurgy and has a beneficial effect on the intensification of the development and improvement of the technical and economic indicators of the operation of nonferrous metallurgy enterprises in fraternal countries.

Using the scientific and technological potential of its nonferrous metallurgy, the Soviet Union has helped and continues to help CEMA countries in constructing 77 enterprises and projects of this branch, of which 60 have already been put into service. For instance, with technical assistance of the USSR's Ministry of Nonferrous Metallurgy a number of enterprises have been built in Bulgaria, such as the lead-zinc plant in Kyrdzhali, the Damyanov copper smelting facility and the Blagoyev integrated nonferrous metals works. The Soviet Union is rendering aid to the Republic of Cuba in modernizing existing

enterprises and constructing new nickel plants in Punta Gorda and Las Camariocas. In 1981 a large "Erdenet" copper-molybdenum mining-dressing complex was put into operation in Mongolia.

Joint development, research, and design figure prominently in cooperation among enterprises and organizations of nonferrous metallurgy of the socialist countries. At present 40 such works are under way. Good results have been attained by the Norilsk mining-metallurgical complex and the Polish Kuprum Institute in finding the basic technical solutions for an underground mine of the near future: within the framework of this cooperation the sides studied the conditions of specific ore deposits and exchanged appropriate technical documentation.

Fruitful cooperation is maintained also with other socialist countries, including the Democratic People's Republic of Korea and Yugoslavia.

The USSR is actively helping developing countries--Algeria, Guinea, Congo, India, Egypt and Turkey--to build mining and metallurgical enterprises. All told, 23 Soviet-aided nonferrous metallurgy enterprises and projects have been built or are under construction in newly free countries. Eight of them have already been put into service. They contribute to the development and growth of one of the most complicated and promising spheres of the national economy and make it possible to raise considerably the export potential of these states.

The High Technological Level

The results of research and development in Soviet nonferrous metallurgy have won world-wide recognition. For instance, Soviet specialists have worked out advanced technological schemes and equipment for the large-scale comprehensive production of alumina, sodium products, potassium fertilizers and cement from low-grade aluminum-bearing ores (nepheline and alunite). These schemes and devices have no analogs abroad.

Interest in purchases of Soviet technology and know-how in nonferrous metallurgy is constantly growing all over the world. The Japanese Nippon Light Metal company and the Canadian Alcan company have been among the first foreign firms to conclude license agreements on the use of Soviet technology. The Soviet bus arrangement system for aluminum electrolyzers, which they bought in 1970, made it possible to sharply raise the capacity of the units at enterprises of Japan and Canada. The American Magnesium Corporation has bought Soviet technology and equipment for the production of magnesium by the electrolytic method. The United States has also bought the Soviet license for the electrolytic method of producing aluminum-silicon alloys through the direct reduction of aluminosilicates in ore-smelting furnaces.

Foreign companies have purchased over 100 Soviet licenses for the production of nonferrous metals. This country possesses 257 valid patents in this field of technology.

In its turn our nonferrous metallurgy makes use of foreign countries' advanced experience. Soviet organizations conclude agreements on deliveries of imported equipment to our enterprises.

Businesslike Partnership

Our relations with the well-known French company Aluminium Pechiney is a vivid example of fruitful cooperation between Soviet organizations and foreign partners. The French firm participated in the construction of the Tajik aluminum plant and the Nikolayev alumina plant.

The general designing of the Nikolayev plant and general coordination of work on this project are carried out on the Soviet side by the Leningrad-based All-Union Research and Design Institute of the Aluminum, Magnesium and Electrode Industry (VAMI). Over twenty design and research organizations have taken part in elaborating the technical documentation for the construction of the plant. The firm worked out the technical documentation for the plant's construction in parallel in the USSR and France.

In the course of the design of the project jointly with French specialists the handing over of the drawings of individual parts of the project for the basic production was ensured at priority rates together with the elaboration of the detail design and also of the documentation for the components of the infrastructure, various auxiliary facilities of the plant and engineering networks.

To deliver the most up-to-date equipment to the Nikolayev alumina plant, the Aluminium Pechiney company has invited a number of experienced French subcontractors, including the Fives-Cail-Babcock company which earlier supplied the Achinsk alumina plant with equipment, the famous Creusot-Loire firm which now delivers equipment to enterprises of the gas industry, the Escher Wyss company, a well-known supplier of heat exchange and evaporation equipment, and the Lurgi company (West Germany), which is a supplier of equipment for the Oskol electrometallurgical plant.

Equipment for the automation of the process and electrical engineering equipment was delivered by French firms--Control Belle and Saunier-Duval. Special equipment for receiving and storing ore was bought from the West German firms--Krupp and Weserhutte--under independent contracts.

In the most intensive periods of construction up to 11,000 Soviet builders, assembly workers and adjusters and over 100 contract supervisors of the Aluminium Perchiney company worked at the construction site.

In September 1980 the first stage of this sophisticated and large plant was put into operation.

In September 1982 the last stage was started up. Thus the production of alumina at the plant has reached its full capacity.

For more than two years Soviet aluminum plants have been processing Nikolayev alumina. A portion of ready-made aluminum is sent to the French side as compensation for its expenses on the construction of the Nikolayev plant.

Despite Ill-Wishers' Intrigues

Our relations with American firms have taken a different turn. For about three years Soviet foreign-trade organizations conducted talks with the American Alcoa company about its participation in the construction of the Sayansk aluminum plant. When the preparation of the contract was completed, representatives of the firm reported that the US Administration placed an embargo on the deliveries of American equipment to the USSR. Soviet metallurgists themselves designed the Sayansk aluminum plant and now the plant is being successfully built. Naturally, the US leaders have inflicted damage not on the Soviet people, but on the American people by canceling by their decisions the big orders for deliveries of equipment to the Soviet Union.

Despite the intrigues by the opponents of mutually advantageous trade and economic ties between capitalist countries and socialist states many West European and Japanese firms have been continuing successful cooperation with the Soviet Union. In particular, Soviet-Finnish cooperation, coordinated by a joint Working Group, is actively developing. With the assistance of this group some Finnish firms, headed by the Outokumpu Joint-Stock Company, have signed a big contract for the delivery of complete sets of Finnish equipment for some operations, for instance, for the manufacture of copper and nickel semi-finished items. They will be delivered to the Nadezhda metallurgical plant, which is a component part of the Norilsk mining-metallurgical complex. The plant has already been assembled and is operating efficiently. Finnish firms have fulfilled orders to the tune of about 250 million roubles.

CSO: 1842/5

UDC: 546.83'73'74'11

SINTERED ZrNi INTERMETALLIDE AS HYDROGEN ACCUMULATOR

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 82
(manuscript received 29 Sep 81) pp 39-44

YENDRZHEYEVSKAYA, S. N., ANTONOVA, M. M., SKOROKHOD, V. V., LUK'YANCHIKOV, V. S., SHABLINA, A. G., SHALYA, I. M., KHORPYAKOV, O. T. and BRATANICH, T. I., Institute of Materials Science Problems, Ukrainian Academy of Sciences; Institute of Gas, Ukrainian Academy of Sciences

[Abstract] Results are presented from a study of the sorption properties of the intermetallide ZrNi obtained by powder metallurgy methods. Powder metallurgy allows a significant reduction in temperature and time of synthesis, eliminating homogenizing annealing. Material is produced as porous brickettes of a predetermined size, eliminating the need for crushing before use. The studies showed that ZrNi obtained by this method is equal to me ted ZrNi in sorption characteristics and has a number of technological advantages. The rate of liberation of hydrogen from hydrogenated ZrNi at temperatures over 473°K is quite high. This material can therefore compete with $LaNi_5$ and TiFe in many proposed areas, including transportation, where heat liberated by exhaust gases is used to decompose the hydride. Figures 5; references 7: 3 Russian, 4 Western.
[43-6508]

UDC: 533.17

POWDER METALLURGY OF AMORPHOUS METAL SYSTEMS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 267, No 3, Nov 82
(manuscript received 18 May 82) pp 619-623

GRYAZNOV, G. M., LAPOVOK, V. N., NAUMENKO, I. G., SERBIN, V. I. and TRUSOV, L. I.

[Abstract] Powders of alloys of iron with nickel, boron, phosphorus, chromium and carbon were obtained by the use of a pulsed plasma channel.

The energy and repetition frequency of pulses fed to electrodes made of the homogenized initial alloy were selected to achieve maximum production with 100% amorphous powder yield. The powders were compacted following particle size separation by sedimentation. X-ray and differential thermal analyses of pressings revealed no crystalline phases. The physical characterisitcs of pressings and powders are presented. The results obtained indicate the promise of the use of powder metallurgy methods for the manufacture of amorphous metal products, allowing the production of massive, homogeneous products. Amorphous powders can also be used to produce composite materials. Figures 4; references 4: 1 Russian, 3 Western.
[41-6508]

UDC: 669.24/25:539.376.548.4

INFLUENCE OF PACKING DEFECT ENERGY ON HIGH TEMPERATURE CREEP OF NICKEL-COBALT ALLOYS

Kiev PROBLEMY PROCHNOSTI in Russian No 10, Oct 82
(manuscript received 10 Dec 81) pp 40-46

NERODENKO, L. M., and DABIZHA, Ye. V., Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences, Kiev

[Abstract] The purpose of this work was to study the influence of packing defects on dislocation creep parameters, which determine the creep resistance in the steady state. These parameters include subgrain size, distance between steps of helical dislocations, microscopic elasticity limit, mobile dislocation density, and the rate of movement of dislocations within subgrains and upon crossing of subgrain boundaries. Two alloys in the nickel-cobalt system (25 and 65% Co) were the object of the study. Creep tests were performed under constant stress in a vacuum with automatic recording of the creep curve in the 700 to 1000°C interval. It was found that the rate of steady creep was determined by the process of generation of subgrain boundary dislocations. The limiting role of the rate of passage of dislocations through cell walls during creep was also noted. Figures 6; references 39: 22 Western, 17 Russian.
[38-6508]

UDC: 669.0:532.74:541.7

MECHANISM OF STRUCTURAL TRANSFORMATIONS IN LIQUID METALS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 267, No 2, Nov 82 (manuscript received 1 Feb 82) pp 367-370

NOVOKHATSKIY, I. A., ARKHAROV, V. I., academician, Ukrainian Academy of Sciences, and LAD'YANOV, V. I., Odessa Polytechnical Institute

[Abstract] A study is made of the kinematic viscosity polytherms of very pure liquid aluminum, tin, lead, bismuth, indium and cadmium heated to 400-1100°C above the melting point. Viscosity measurements were performed with isothermal holding by twisting oscillation of the crucible containing the melt. The experimental data indicate that polymorphous transformations occurring in metallic fluids (and in melts in general) as the temperature rises basically occur by sudden changes in one of the cluster lattice parameters while preserving the general type of packing of atoms in the clusters. It can be assumed that there are various types of polymorphism in liquids resulting from changes in various factors such as temperature, composition, pressure, magnetic and electric field intensity. Apparently only two types of polymorphism have yet been observed in melts: thermal and concentration polymorphism. Figures 2; references 13: 12 Russian, 1 Western. [46-6508]

UDC 669.17:621.785.16

POLYMORPHIC $\alpha \rightarrow \beta$ TRANSITION IN COMMERCIAL TITANIUM UNDER RAPID HEATING

Minsk DOKLADY AKADEMII NAUK BSSR in Russian Vol 27, No 1, Jan 83 (manuscript received 11 Jun 82) pp 46-48

[Article by A.I. Gordiyenko, Physicotechnical Institute, Belorussian SSR Academy of Sciences, presented by Belorussian SSR Academy of Sciences Academician K.V. Gorev]

[Text] The study of critical points in pure and commercial titanium under rapid heating is of great importance for understanding the mechanism and kinetics of the process of phase recrystallization in titanium alloys.

There is limited information in the literature on the influence of the heating rate on the temperature range for the $\alpha \rightarrow \beta$ transition in pure and commercial titanium. In a study made earlier it was established that increasing the sudden heating rate to 10^7 °C/s is accompanied by a 90 °C shift in the temperature for the beginning of the polymorphic $\alpha \rightarrow \beta$ transition [1].

In this paper a study is made of the position of critical points in alloy VT1-0 under isothermal and continuous heating at rates in the range of 1 to 1000 °C/s. The study was conducted in sheet specimens of VT1-0 titanium 1 mm thick, containing as impurities 0.09% Fe, 0.03% Si, 0.03% C, 0.03% O_2, 0.0006% H_2 and 0.02% N_2. Stabilizing preannealing of the specimens was performed in a vacuum oven at 750 °C for 30 min followed by slow cooling with the oven. The temperature was measured by means of a 0.1-mm Chromel-Alumel thermocouple welded to the specimen. The temperature in the process of heating by passing current through was recorded by means of an N041 UCh. 2. mirror-galvanometer oscillograph. The critical and instrument points for the beginning and end of the polymorphic $\alpha \rightarrow \beta$ transition were determined from breaks in the oscillogram.

As was demonstrated in [2], under these experimental conditions heating at rates of up to 2000 to 3000 °C/s does not cause pronounced inertial distortions in measurement of temperature, and an oscillographic recording of the thermal curve can be fully used for determining critical points. Here it must be kept in mind that the moment of the bend does not correspond to the true beginning of the $\alpha \rightarrow \beta$ transition, when the first nuclei of the beta phase appear, but reflects only a specific stage in the development of the transition. Therefore, there can be a question of a so-called instrument critical transition point. In studying the $\alpha \rightarrow \gamma$ transition in steel the moment of formation of approximately 5% austenite is usually taken as the instrument critical point [5].

Under conditions of slow isothermal heating the $\alpha \rightarrow \beta$ transition in alloy VT1-0 begins at 850 °C and ends at 880 °C. The transition range is 30 °C. Impurities and their distribution have a considerable influence on lowering of the transition temperature in commercial titanium.

A small quantity of impurities in iodide titanium (0.2 to 0.25%) results in the appearance of a transition range. Beginning at 882 °C, the $\alpha \rightarrow \beta$ transition takes place basically at a constant temperature and the last sections of the alpha phase are transformed at a higher temperature. In magnesium-thermal and commercial titanium with a great number of impurities the polymorphic transition develops in the temperature range of 100 to 120 °C [4, 5]. An increase in the impurity content causes a drop in the temperature at which the transition begins, to 850 to 860 °C.

In VT1-0 commerical titanium, with annealing in the alpha region or with slow cooling from the beta region, segregation zones form with a heightened content of beta-stabilizing impurities or a so-called "second phase," representing the alpha phase of different alloyage as compared with the matrix, but not having an interface with it [6-8].

Zones of chemical microinhomogeneity enriched with beta-stabilizing impurities will have less thermodynamic stability with regard to subsequent heating. Most probable is the development of the $\alpha \rightarrow \beta$ transition at the initial stage along grain boundaries where microvolumes with a heightened content of beta-stabilizing elements are most often detected.

The boundaries of recrystallized grains represent sites of a defect-type crystal structure. The diffusion mobility of impurity atoms in interacting with defects of the crystal lattice at the polymorphic transition temperature is three orders of magnitude higher than in the case of ordinary diffusion [9]. This is probably one of the main reasons for localization of sections of chemical microinhomogeneity along boundaries between grains.

In VT1-0 commercial titanium the presence of segregation zones appears in formation of the beta phase at temperatures below thermodynamic equilibrium (882 °C). The first segregations of the lamellar beta phase under isothermal annealing are detected metallographically primarily along the boundaries of polyhedral alpha grains at 850 °C. Microvolumes having undergone double phase recrystallization, $\alpha \rightarrow \beta \rightarrow \alpha$, differ in terms of etching from the untransformed alpha phase. In addition to the boundary beta phase, lamellar segregations of the beta phase measuring 3 to 5 μ within polyhedral alpha grains are observed in considerably smaller quantities. The predominance at the initial stage of transition of the beta phase of a lamellar type testifies to the preferential development of the $\alpha \rightarrow \beta$ transition according to a shift mechanism, which was observed earlier in [10-11]. An unordered mechanism for the $\alpha \rightarrow \beta$ transition predominates in proportion to a rise in temperature in the transition range. New acicular nuclei almost do not form and development of the transition on account of shifting of the interphase boundary occurs so that the residual alpha phase acquires a polyhedral shape. The original grain is restored in the process of the $\alpha \rightarrow \beta$ transition and after transition of the last sections of the alpha phase into the beta phase at 880 °C intensive collective growth of beta grains begins. Recrystallization on account of precipitation hardening is absent.

Nuclei of the high-temperature beta phase under nonequilibrium conditions, i.e., with rapid continuous heating, appear at a higher temperature as compared with isothermal annealing.

Typical thermal curves recorded on an oscillogram while heating at various rates (fig 1) testify to the fact that the polymorphic transition takes place in a certain temperature range. As demonstrated by a determination of critical points from bends on a thermal curve for a heating rate of 100 °C/s, the $\alpha \rightarrow \beta$ transition begins at 878 °C and ends at 900 °C, i.e., the overheating relative to the temperatures for the beginning and end of the polymorphic transition, determined under isothermal conditions, with rapid heating equals 28 and 20 °C, respectively.

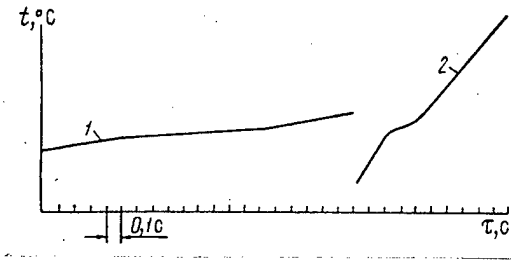

Figure 1. Oscillograms for Heating of Specimens of VT1-0 Titanium at Rates of 100 (1) and 1000 °C/s (2)

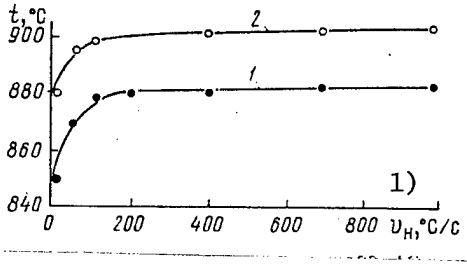

Figure 2. Influence of Heating Rate on Temperature for Start (1) and End (2) of $\alpha \rightarrow \beta$ Transition for VT1-0 Commercial Titanium

Key:

1. v_n [heating rate]

The influence of the heating rate on the position of critical points for alloy VT1-0 is illustrated in fig 2. As follows from the results of determining critical points, considerable overheating is observed with an increase in the heating rate to 100 °C/s, and in the range of 100 to 1000 °C/s the additional shifting of critical points in relation to equilibrium transition temperatures is quite insignificant. The temperature for the end of the transition when heating at a rate of 1000 °C/s equals 905 °C. In the rate range of 1 to 100 °C/s a constant rise is observed in instrument-recorded transition points with some slowing of the rate of growth in proportion to an increase in heating rate. As compared with isothermal

annealing, accelerated heating causes narrowing of the phase recrystallization range from 30 to 22 °C.

Thus, the experimental results testify to the fact that instrument-recorded points for the polymorphic $\alpha \rightarrow \beta$ transition, with an increase in the heating rate, undergo a shift into the higher-temperature region.

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8831
CSO: 1842/67

UDC: 536.2.212:669.295

TEMPERATURE AND THERMAL CONDUCTIVITY OF SOLID AND LIQUID TITANIUM

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 267, No 3, Nov 82
(manuscript received 14 Jul 82) pp 602-604

GEL'D, P. V., IL'INYKH, S. A., TALUTS, S. G. and ZINOV'YEV, V. Ye., Urals Polytechnical Institute imeni S. M. Kirov, Sverdlovsk, Sverdlovsk Mining Institute imeni V. V. Vakhrushev

[Abstract] Measurement of temperature conductivity *a* was performed by a variant of the method of flat temperature waves. A constant electron flux bombarded the surface of a thin metal plate. The flux was modulated by an audiofrequency voltage and the phase delay of the temperature wave on the opposite side was measured. To assure the necessary speed and sensitivity, a phase difference meter recorded the phase difference during each period of modulation and a computer was used to record and process the results of phase measurement for each period. The results of temperature conductivity polytherm studies are presented graphically. The thermal conductivity of titanium at high temperatures was found to be determined primarily by the contribution of electrons. Figures 2; references 8: 6 Russian, 2 Western. [41-6508]

UDC: 539.385

INFLUENCE OF FATIGUE CRACK SIZE AND SHAPE ON CYCLIC FRACTURE TOUGHNESS OF VT9 TITANIUM ALLOY

Kiev PROBLEMY PROCHNOSTI in Russian No 10, Oct 82
(manuscript received 9 Dec 81) pp 34-37

BEGA, N. D., Institute of Material Science Problems, Ukrainian Academy of Sciences, Kiev

[Abstract] The purpose of this work was to establish the influence of fatigue crack size and shape on the cyclical fracture toughness of VT9

titanium alloy. The alloy was studied in the $\alpha+\beta$ state, and thermally stabilized by annealing at 1223°K for 60 minutes, cooling in air to 803°K, and holding for 6 hours. The yield point was 1020 MPa, strength 1120 MPa. Smooth cylindrical specimens with a gage length of 30 mm and a diameter of 10 mm were used. Fatigue cracks with similar dimensional characteristics were produced at different stresses depending on the cycle asymmetry factor. The studies showed that regardless of σ_{max} and cycle asymmetry the superficial crack arc length s varied in proportion to l_{fc}. The data indicate that in the area of σ_{max} close to the yield point, the plastic deformation accumulated before fracture during cyclical loading creates conditions for structural changes in VT9 and is the basic cause for the great decrease in cyclic fracture toughness. Figures 3; references 5: 3 Russian, 2 Western.
[38-6508]

UDC: 669.295:539.4.019.3

INFLUENCE OF OXIDATION AND GAS SATURATION PROCESSES ON MECHANICAL PROPERTIES OF VT1-0 AND VT14 TITANIUM ALLOYS

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 18, No 5, Sep-Oct 82 (manuscript received 16 Aug 81) pp 61-64

MAKSIMOVICH, G. G., FEDIRKO, V. N., LIZUN, A. T. and BUNIN, L. A., Physical-Mechanical Institute imeni G. V. Karpenko, Ukrainian Academy of Sciences, L'vov

[Abstract] Results are presented from a study of the influence of oxide and gas saturated layers arising upon annealing in air of VT1-0 and VT14 alloys at 400, 500 and 600°C with holding times of 1, 3, 5 and 10 hours on the strength properties of the alloys. Specimens of three types were used: 10 x 15 x 1 mm specimens for metallographic, x-ray spectral studies and gas analysis; 50 x 30 x 1 mm specimens for heat resistance studies, and small specimens with gage section 2 x 1 mm for strength testing. The specimens were annealed in air and in a vacuum, with a holding time of 10 hours. Heating and cooling rates were always 0.24°C/sec. It was found that at 400 and 500°C oxidation follows a cubic law, and at 600°C a parabolic law. VT1-0 gained more mass at all temperatures studied than VT14, the difference increasing with increasing temperature. It was found that when exposed to air, VT1-0 and VT14 form an oxide film of up to 100 nm, primarily with rutile structure and a gas saturated layer which varies in depth from 5 to 10 μm depending on temperature and time. The strength increases only if the gas saturated layer is about 10 μm thick. The increase in microhardness of the VT1-0 gas saturated layer is accompanied primarily by an increase in yield point. The variation is similar for VT14, except that the microhardness of the surface layer is much greater and tensile strength therefore increases by approximately 100 MPa. Hardening of VT14 may also be accompanied by an increase in hydrogen content. Figures 3; references 6: all Russian.
[40-6508]

UDC: 669.295'71'28'26'1'782:539.4.015

INFLUENCE OF HEAT TREATMENT CONDITIONS ON FINE STRUCTURE AND MECHANICAL PROPERTIES OF VT3-1 TITANIUM ALLOY

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 54, No 4, Oct 82 (manuscript received in final form 14 Jan 82) pp 767-773

TRENOGINA, T. L., ZVEREVA, Z. F., KATAYA, G. K., MESHCHANINOVA, L. S., LERINMAN, R. M., VOZILKIN, V. A. and TEYTEL', Ye. I., Institute of Metal Physics, Urals Science Center, USSR Academy of Sciences

[Abstract] A study is made of high strength VT3-1 alloy, a typical representative of two phase α+β titanium alloys. Bars 30 mm in diameter with chemical composition 6.2% Al, 1.93% Mo, 1.43% Cr, 0.57% Fe, 0.21% Si, 0.02% N, 0.008% H, 0.09% O, remainder Ti, were studied. The bars were manufactured by rolling at temperatures in the β area, then in the α+β area. Compression in the two-phase area was 75%. The bars were heat treated at 920°C 1 hour, then at 550 and 650°C for 2 hours. Three versions of cooling rates after high temperature annealing (first stage) were studied: cooling with the furnace to the second stage, moving to a furnace heated to the second stage temperature, cooling in air to room temperature. The alloys were cooled in air after the second stage. Two stage heat treatment creates a number of factors which have unfavorable influence on mechanical properties. Mechanical properties are improved by transfering the specimens to the furnace at 550°C, which strengthens the initial β grains by the development of α plates forming a "basket weave" structure. Figures 6; references 10: 7 Russian, 3 Western.
[51-6508]

UDC: 669.295'71'28'292:621.785.78

INFLUENCE OF INITIAL STRUCTURE ON DECOMPOSITION OF β SOLID SOLUTION IN HIGH STRENGTH VT22 TITANIUM ALLOY

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 54, No 4, Oct 82 (manuscript received 6 May 81; in final form 2 Dec 81) pp 755-761

NOTKIN, A. B., KOROBOV, O. S., PERTSOVSKIY, N. Z., POL'KIN, I. S., SEMENOVA, N. M. and SMOLYAKOVA, L. A.

[Abstract] A study was made of the process of aging in high strength VT22 titanium alloy with various β solid solution structures formed after hot deformation. The specimens quenched in water with initial recrystallization and various dislocation structures were annealed at 200 and 850°C for 1 minute to 10 hours. To produce a polygonized structure the specimens were deformed to about 40% at 950°C. The recrystallization structure was obtained by heating to 1050°C. After deformation and annealing the specimens were

quenched in water. A study of the fine structure of phases liberated upon aging indicated the optimal structure providing the best combination of mechanical properties. It is a composite structure consisting of a mixture of plastic α phase particles located at the boundaries of subgrains and finely dispersed hardening plates of α" and α' martensite located within the subgrains. The composite structure can be produced by achieving a good polygonized structure in the β solid solution by hot deformation and multistage heat treatment. Figures 6; references 10: 7 Russian, 3 Western. [51-6508]

STUDY OF ELECTRODE SURFACE STRUCTURE UPON ELECTRIC SPARK ALLOYING OF VT-18 TITANIUM WITH NICKEL

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 5, Sep-Oct 82 (manuscript received 3 Mar 81) pp 30-33

PILYANKEVICH, A. N., PADERNO, V. N., VERKHOTUROV, A. D. and MARTYNENKO, A. N., Kiev

[Abstract] A detailed study is presented of the structure of VT-18 titanium alloy after electric spark alloying with nickel. The structure of the alloy is determined as a function of spark processing time per unit of area. At relatively short times, 1 to 2 minutes per square centimeter, the first signs of brittle fracture appear. As the specific time increases, brittle fracture begins to predominate and in this case the weight of the part being worked decreases and may be less than the initial weight. The studies performed allow selection of the optimal conditions of electric spark alloying. When mode II is used the process should continue for 4 to 5 minutes per square centimeter; for mode V the best results are obtained at 10 to 12 minutes per square centimeter. Figures 4; references 4: all Russian. [34-6508]

UDC: 669.295.5:669.788.539.56

INFLUENCE OF HYDROGEN ON TITANIUM ALLOY FRACTURE MICROMECHANISM

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 43, No 3, Sep 82 (manuscript received 23 Mar 79; in final form 23 Feb 82) pp 617-620

MAL'KOV, A. V., KOLACHEV, B. A. and MISHANOVA, M. G., Moscow Aviation Technology Institute imeni K. E. Tsiolkovskiy, Stupinsk Branch

[Abstract] The purpose of this work was to establish the relationship between the mechanical properties of titanium alloys and microfracture processes by special microfractographic research methods. Analysis of mechanical testing of hydrogenated specimens in complex stress states yielded the answers to a number of problems concerning the operating qualities of titanium structures

and provided important information on the nature of phenomena causing hydrogen embrittlement. It was established that microfractographic analysis based on the appearance of the first areas of specific brittle relief can be used to determine the concentration of hydrogen at which the metal begins to manifest elevated sensitivity to brittle fracture. The indirect influence of hydrogen on titanium alloys causes the following microstructural changes: 1) an increase in the quantity of β phase stabilized by hydrogen at room temperature; 2) development of β converted microstructure upon hot pressure working or heat treatment; 3) formation of partially or completely recrystallized structure during standard heat treatment; 4) active redistribution of alloying elements between α and β phases resulting in enrichment of the α phase with aluminum and its embrittlement. Figures 2; references 6: 5 Russian, 1 Western.
[35-6508]

UDC: 669.295.5:621.785.78:620.181

STUDY OF SECOND PHASE SEPARATION PROCESSES IN VT30 TITANIUM ALLOY

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 43, No 3, Sep 82 (manuscript received 12 Jun 81) pp 590-592

POPOV, A. A., ANISIMOVA, L. I. and BELOGLAZOV, V. A., Urals Polytechnical Institute imeni S. M. Kirov

[Abstract] This work studies the regularities of the decomposition of the supersaturated β solid solution in VT30 titanium alloy. Two approaches were used: continuous heating of specimens at 100°C/hr over the 20-800°C range and isothermal aging at various temperatures. The decomposition of the β solid solution may result in the formation of α or ω phases. If the intermediate ω phase is formed (in the 300 to 400°C temperature interval), it is most probable that the α phase will arise at the interphase β-ω boundary and the morphology of the α and ω particles will be identical. With longer aging at 400°C or at higher temperatures (over 500°C) liberation of the α phase in the form of plates is more probable. The main loci of formation in this case are crystalline structure defects. Figures 3; references 6: 5 Russian, 1 Western.
[35-6508]

UDC: 669.295:539.4.01/019

MECHANISM OF DEFORMATION AND FRACTURE OF LARGE CRYSTALLINE TEXTURED α TITANIUM ALLOYS

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 6, Nov-Dec 82 (manuscript received 8 Jul 81) pp 152-157

BABAREKO, A. A. and EGIZ, I. V., Moscow

[Abstract] A study of the crystallographic nature of α titanium alloy is undertaken, using analysis of the nature of fracture of titanium alloys, data on texture and shape changes of specimens, as well as diffractographic data. Large crystalline rolled α titanium alloys in the system Ti-Al-U were used. Four inverse band figures were constructed for each specimen by comparing the integral reflex intensity of the spectra of the specimen and an untextured standard with standardization of all reflexes by the method of Morris. The first three IPF were used to construct a direct pole figure representing the distribution of basis planes in the material. One of the probable positions of the fracture surface was then applied to the full direct pole figure. Study of a large batch of these specimens revealed several typical cases. The change in orientation upon twinning of individual texture components was studied. In all cases of twinning the orientation of the twins was produced rather distant from the orientation of the main component. The relationship is established between the nature of shear fracture, shape change and deformation mechanism of the specimens. For a layered material with heterogeneous texture with a main prismatic component the twinning texture is theoretically derived as usually observed after hot plus warm or cold rolling in twinning α titanium alloys. Figures 5; references 3: all Russian.
[52-6508]

UDC: 669.295:620.186

STUDY OF FINE STRUCTURE OF SPONGE TITANIUM

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 6, Nov-Dec 82 (manuscript received 6 Mar 81) pp 67-70

ALEKSANDROVSKIY, S. V., TITARENKO, A. I., CHEREPANOVA, Ye. A., GOLIKOV, V. V. and KRASOTKIN, I. S., Leningrad

[Abstract] Scanning electron microscope investigation of local samples from a block of sponge titanium showed that the largest grains and most compact structure are formed in the side and bottom zones of the block, with only individual thin pores present. In the central portion of the block the sponge is made up of individual grains with clearly visible growth steps, with the grain boundaries partially retaining the shape of the primary

crystals, in some cases hexagonal in outline. Samples from the top zone consist of extended grains with dendritic shape, the mass of the titanium being loose and porous. The studies performed show that the physical characteristics of the sponge are significantly influenced by the dimensions of the reaction vessel: as the diameter increases the overall porosity of the sponge in the central portion of the block significantly decreases. The influence of such technological factors as process speed, magnesium utilization of the factor and duration of vacuum separation on the structural characteristics of the sponge titanium is noted. Figures 1; references 4: all Russian.
[52-6508]

UDC: 669.18

WELDING AND SPECIAL ELECTROMETALLURGY IN THE USSR - BASIC ACHIEVEMENTS

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 6, Nov-Dec 82 (manuscript received 3 Jul 82) pp 21-26

PATON, B. Ye., Kiev

[Abstract] The Soviet economy is well supplied with welding equipment, making the technical level of welding in the Soviet Union among the highest in the world. Electric arc welding plays a leading role in the broad range of welding processes and will remain the most important type of fusion welding for the foreseeable future. An important stage in the development or arc welding was the creation in the late 1930's of highly productive automatic welding machines working under flux. Powder wire welding features good quality, economy and universality. Plasma welding or flat arc welding is used to join thinwall stainless steel structures. Electric slag welding was created in the USSR based on a deep study of the physical phenomenon of conductivity of oxide and halide melts. Vacuum arc and underwater arc welding have now also become common. The possibility has been demonstrated in principle ofperforming welding in space. New reinforced quasi-monolithic materials have been created for such important jobs as gas pipelines in the frozen north. Electric slag remelting of electrodes has created a new branch of industry called special electrometallurgy. Unfortunately, for many years the question of quality of the metal to be welded was not given sufficient attention. Remelting under a vacuum is now used to remove undesirable hydrogen and oxygen from metals before use. Problems of the theory and practice of increasing metallurgical quality of steels and alloys and of their welding are closely interrelated.
[52-6508]

UDC: 621.791.76:621.7.044.2:534.222.2

INSTABILITY OF DETONATION OF HETEROGENEOUS EXPLOSIVES AND ITS INFLUENCE ON EXPLOSIVE CLADDING OF LARGE SHEETS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 82
(manuscript received 29 Jan 82; in final form 23 Mar 82) pp 18-22, 50

DANILENKO, V. A., candidate of physical and mathematical sciences, KUDINOV, V. N., doctor of technical sciences, KOROTEYEV, A. Ya., candidate of technical sciences, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences

[Abstract] Results are presented from studies of the stability of detonation of large explosive charges used for explosive welding. The relationship of detonation stability to specifics of the process of cladding of large sheets is also studied. Detonation stability was studied using flat charges of explosives with length over 3.5 d, initiated by flat wave generators. Detonation waves were found to propagate with unstable pulsating leading edges. The formation of the pulsating waves is analyzed. Even though steady, stable waves were initiated in the explosives, at $l > 3.5$ d the waves propagated unstably. This forms a complex three-dimensional periodic structure with local areas of elevated pressure and temperature. After detonation stability is lost periodic disturbances appear transverse to the leading edge of the wave, resulting finally in a decrease in titanium-steel bimetallic joint strength. Ultrasonic processing of explosives used in explosive welding of large products should be used to prevent a decrease in joint strength. Figures 9; references 10: 9 Russian, 1 Western.
[33-6508]

UDC: 621.791.4:539.378.3:[669.71+666.192]

INTERACTION OF METALS WITH CERAMIC OXIDES IN DIFFUSION WELDING

Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 82
(manuscript received 17 Nov 81; in final form 23 Jun 82) pp 15-17

BACHIN, V. A., candidate of technical sciences, Moscow Aviation Technical Institute imeni K. E. Tsiolkovskiy

[Abstract] Better understanding of the processes by which metals are joined to nonmetals requires analysis of the mechanisms of formation of spinel and simple exchange reactions. Analysis of the interaction of corundum ceramic with 29MK (kovar) alloy has shown that the formation of compounds occurs through oxide layers which grow on the metal. Though the mobility of ions during diffusion of welding is not high, reliable joints between metals and ceramics have been achieved. According to an idealized scheme, successive layers of aluminum, Al_2O_3, silicon and SiO_2 should be formed. During diffusion welding of a multicomponent glass through a thin aluminum interlayer

even with long isothermal holding no formation of parallel layers of reaction product was observed. Individual chaotically oriented new phase crystals were observed. In diffusion welding of kovar with corundum, an interaction occurs through oxide layers by an attachment reaction; when silicon is welded to aluminum the interaction is by substitution. The reaction products are first dissolved in the aluminum, then as isothermal holding continues the solid supersaturated solution begins to precipitate and the Al_2O_3 and silicon phases are separated, causing the growth of stresses in the contact zone and reduced working characteristics. Figures 5; references 14: all Russian.
[33-6508]

UDC: 621.791.052:[620.17+620.193]:669.71.018

MECHANICAL AND CORROSION PROPERTIES OF AMg2-1915 ALLOY WELDED JOINTS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 11, Nov 82
(manuscript received 18 Feb 82) pp 47-49

IGNAT'YEV, V. G., candidate of technical sciences, SEMENYUK, N. I., BOYEVA, G. Ye., TRUSH, A. I., engineers, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences

[Abstract] Mechanical and corrosion tests of welded joints in 500 x 300 x x 3 mm sheets of the alloys AMg2 and 1915 are performed. The sheets were joined along an edge 300 mm in length by a mechanized argon arc welding machine using a tungsten electrode with welding current 240 A, welding speed $3.3 \cdot 10^{-3}$ m/sec, electrode diameter 5 mm, wire diameter 2.0 mm, wire advance $13.6 \cdot 10^{-3}$ m/sec. Mechanical properties of the welded joints were determined by testing of specimens cut across the joint, 6 specimens for each type of welding 150 days after welding. The short-term strength of the joints after both natural and artificial aging was similar to the values for joints in AMg2 alloy. The corrosion resistance of the welded joints depends on the initial state of the alloys. Artificial aging of 1915 alloy reduces corrosion resistance of joints due to localization of corrosion near the melted zone. Figures 4; references 6: all Russian.
[49-6508]

UDC: 621.791:[669.295.868:669.14]

WELDING OF TITANIUM-STEEL BIMETAL

Kiev AVTOMATICHESKAYA SVARKA in Russian No 11, Nov 82
(manuscript received 24 Nov 81; in final form 1 Mar 82) pp 43-46

KONYUKHOV, A. V., SANNIKOV, V. I., IVANOV, B. V., engineers, Uralkhimash Production Union, SEMENOV, B. G., MARTEM'YANOVA, Z. S. and ROSSOKHIN, B. G., candidates of chemical sciences, Institute of Electrochemistry, Urals Scientific Center, USSR Academy of Sciences

[Abstract] The possibility of using tungsten carbide, chromium carbide, titanium carbide and pure tungsten particles for atomization of the surface of the welded edges in titanium-steel bimetals is studied. Before welding, the titanium layer was removed from the bimetal for 4 mm on either side of the joint. The joint was then welded from the steel side, producing a V-shaped notch; then the steel was shot peened on the titanium side and the powder atomized on the surface. The titanium layer was subsequently welded in two passes with an argon arc welder using a tungsten electrode and VT1-00s 6-mm-diameter welding wire. Tungsten is recommended as the best material for the separating atomized layer in this process. The seam which is produced consists of pure plastic titanium. Its corrosion resistance is equal to that of the titanium of the cladding layer. The thickness of the atomized layer need not be more than 0.05 mm to be effective. Figures 7; references 8: 7 Russian, 1 Western.
[49-6508]

UDC: 621.791.4:539.378.3:669.295

INFLUENCE OF VACUUM ON TITANIUM AND ALLOY JOINT QUALITY IN DIFFUSION WELDING

Kiev AVTOMATICHESKAYA SVARKA in Russian No 11, Nov 82
(manuscript received 25 Mar 82) pp 32-36

PESHKOV, V. V., candidate of technical sciences and PODOPRIKHIN, M. N., engineer, Vodonezh Polytechnical Institute

[Abstract] Studies were performed on specimens of technically pure VT1-0 titanium and on the OT4 and VT5 alloys. Static tensile and impact toughness specimens were welded at the middle of the gage section and cylindrical blanks were also welded, then used to make standard mechanical testing specimens. Decreasing the residual gas pressure from $8 \cdot 10^{-2}$ to $6 \cdot 10^{-3}$ Pa had practically no influence on mechanical properties. The specimens fractured brittly through the joint surfaces. Vacuum welding creates conditions such that the residual gases reaching the contact zone have practically no negative influence on processes controlling the formation of the welded joint. For this reason, further reduction in residual gas pressure has no further influence on mechanical characteristics. As the welding temperature

increases or the welded surfaces are made smoother the influence of the vacuum on mechanical properties of the joint decreases. Figures 6; references 4: all Russian.
[49-6508]

UDC: 621.791.4:539.378.3

ELIMINATION OF DEFECTS IN OT4 TITANIUM ALLOY DIFFUSION WELDED JOINTS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 82 pp 20-21

MATYUSHKIN, B. A., candidate of technical sciences, REDCHITS, V. V., candidate of technical sciences and SEREGIN, G. A., engineer

[Abstract] A study is made of the possibility of selective correction of defects and elimination of situations in which correction of one defective area causes heating and deformation of the entire structure. The purpose of the work was to create diffusion welding conditions only in the defect zone without reheating the entire structure. Heating is performed locally by transmission of heat from the liquid metal formed in the supporting element, while the compressive force is created after the diffusion welding temperature is reached in the defect zone. Defects were corrected in a welded multilayer T-shaped structure measuring 200 x 500 mm made of OT4 titanium alloy sheet. The heat source was a type VSVU-630 welding machine. The possibility is demonstrated of using the thermal energy of an arc to correct diffusion welding defects. Figures 2; references 7: all Russian.
[47-6508]

UDC: 621.791.012.016:669.295

INFLUENCE OF MODE PARAMETERS ON SEAM FORMATION IN WELDING VT20 ALLOY WITH SUBMERGED ELECTRODE

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 82 pp 17-19

FEYGENSON, N. G. and DOLOTOV, B. I., engineers, RYZHKOV, F. N., doctor of technical sciences, and DASHKOVSKIY, A. A. and VERESHCHAGIN, S. I., engineers, Komsomol'sk-na-Amure Polytechnical Institute

[Abstract] The purpose of this work was to develop a technology for bi-directional welding of butt joints in VT20 alloy up to 68 mm thick with increased submersion of the electrode. A GSPD-1 welding machine with a VSV-2000 power supply was used. Welding was performed in helium using lanthanized 10-mm-diameter tungsten electrodes with tip angle $15\pm2°$ and point radius 2 mm. The results of the experiments showed that the use of inserts of VT1-0 titanium, PT3M alloy and other materials did not change the geometric

dimensions of the melting zone. The experimental results were mathematically processed using a NAIRI-K computer. Increasing immersion of the electrode to 23 mm increases welding current, melting depth and effectiveness of arc heat utilization and provides a more stable welding process. Figures 4; references 3: all Russian.
[47-6508]

UDC: 621.791.75:669.715

SELECTION OF METHOD FOR WELDING 1420 ALUMINUM ALLOY

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 82 pp 13-15

MIRONENKO, V. N., candidate of technical sciences, YEVSTIFEYEV, V. S., and KORSHUNKOVA, S. A., engineers

[Abstract] A study is performed to select a method of welding the 1420 Al-Mg-Li alloy so as to maximize strength, toughness and corrosion resistance of joints. The mechanical and corrosion properties of welded joints were studied using 16-mm-thick plates after hardening and cooling in air and artificial aging at 170°C for 18 hours using 3 welding methods: electron beam, argon arc with tungsten electrodes, and helium arc with tungsten electrodes. Electron beam and helium arc welding were performed without a welding wire. Argon arc welding was performed using Sv-AMG6 wire. Helium arc welding produces the best combination of properties including a tensile strength of the joint about 70% that of the base metal and good toughness. Electron beam welding results in porous joints, reducing mechanical properties. Corrosion resistance decreases with increasing specific energy of welding. Figures 4; references 6: all Russian.
[47-6508]

UDC: 621.791.4:539.378.3

DIFFUSION WELDING OF HIGH ALUMINA CERAMIC WITH AMts ALUMINUM ALLOY

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 82 pp 8-9

KARAKOZOV, E. S., doctor of technical sciences; RAVICH, A. M., candidate of technical sciences; KHARLAMOV, B. A., engineer and SHKIROV, V. S., candidate of technical sciences

[Abstract] The purpose of this work was to determine the basic parameters of the thermal deformation cycle of welding providing for the production of precision, sealed, mechanically strong and thermally stable joints between the AMts alluminum alloy and a vacuum-tight ceramic. Welding was performed on a modern STVU-40 welding machine equipped with a special attachment for

measurement of deformation of an aluminum disk. Ceramic specimens containing 89 to 91% crystalline phase and 9 to 11% vitreous phase and disks of AMts alloy 0.3 to 0.45 mm thick were assembled for welding after heat treatment of the ceramic specimens in a silite furnace at 900 to 1250°C for one hour. The possibility is demonstrated of producing airtight high strength welded joints, and parameters of the thermal deformation welding cycle are determined allowing the production of joints with high dimensional accuracy.
Figures 7; references 6: 4 Russian, 2 Western.
[47-6508]

ARTICLE DISCUSSES UTILIZATION OF INDUSTRIAL WASTES IN URALS

Moscow EKONOMICHESKAYA GAZETA in Russian No 52, Dec 82 p 14

[Article, published under the heading "Reflections on a Pertinent Topic," by Academician N. Vatolin, director, Institute of Metallurgy of the USSR Academy of Sciences Ural Scientific Center, Sverdlovsk: "Raw Materials From Waste: On Unresolved Problems of Comprehensive Processing of Ural Ores"]

[Text] At the present time increasing quantities of raw materials are being hauled to the Urals from other parts of the country for the needs of ferrous and nonferrous metallurgy and the chemical industry. Large-output enterprises here, in addition to their principal products, turn out waste in the form of sludges, slags, consumed electrodes, dust, and gases. As a rule these contain valuable constituents in concentrations of commercial interest.

Recovery of secondary resources in the Urals is not yet strongly developed. Therefore the target of achieving comprehensive processing of raw materials contained in the 11th Five-Year Plan is of paramount importance.

It would be erroneous to state that Ural scientists and production people are not working on solving this problem. Thanks to their efforts, much has been accomplished to achieve fuller utilization of mineral resources. Here is a striking example of placing among reserves of commercially-minable minerals ores which were considered substandard. I am speaking of the creation of a large iron-ore reserve based on low-grade titanomagnetite ores of the Kachkanar deposit. Thanks to the recovery of iron and vanadium, the production cost of converter steel at the Nizhniy Tagil Combine is less than that of steel produced from ore mined in the Kursk Magentic Anomaly. And yet the iron content of the latter is two to three times greater than that of the Kachkanar ores. Considerable success has been achieved in comprehensive processing of raw materials in nonferrous metallurgy. Sixteen elements are now being recovered from copper-zinc ores.

There still exists, however, considerable potential for increasing the raw material comprehensive utilization factor, and there are occurring considerable losses of valuable constituents with waste materials. Titanium, copper, chromium, sulfur, zinc, and noble metals are still being lost in the tailing dumps at Ural metallurgical and chemical enterprises. The total metal recovery factor is low.

As much as 80 percent of mined material is dumped together with overburden, beneficiation tailings, slags, sludges, pyrite cinders and other waste. The sulfur utilization factor in nonferrous metallurgy does not exceed 60 percent. Large quantities of valuable constituents are dumped and discharged into the atmosphere.

The problem of waste recovery has long occupied the center of attention of Ural scientists. They have proposed, for example, a number of schemes for processing red muds at alumina plants, production of which is commensurate with output of the principal product -- alumina. Scientists have shown the possibility of utilizing these muds as binding agents and intensifiers in the production of blast-furnace sinter and pelletized ore. Scientists have developed a process of recovering iron and alumina from red muds, using the residue in production of cement.

Each of these methods has been tested to one degree or another in semiindustrial or industrial conditions. But there has not yet been a commercial adoption.

We cannot state that the USSR Ministry of Nonferrous Metallurgy is not showing any interest in this problem. In the general agreement between the USSR Academy of Sciences Ural Scientific Center and the ministry, proper emphasis has been placed on recovery of red muds. We know that a number of branch institutes have been enlisted in this project. The search for the most efficient method, however, has dragged on.

Would it perhaps produce greater effect for the economy to proceed with implementing already tested methods, taking specific local conditions into account? We assume that a certain degree of persistence in this regard will be shown by the USSR State Committee for Science and Technology and USSR Gosplan.

Waste slag generated in copper smelter production exceeds 100 million tons. This slag contains a large quantity of iron, nonferrous and noble metals. Their recovery from the slag is a technically complex problem. Considerable capital spending is required, as well as substantial operating outlays, which at best will generate minimal profitability.

A process developed at our institute seems to be more promising. It produces blister copper in a single operation, makes it possible to increase the degree of sublimation of zinc, lead, cadmium, rare elements, etc. Bringing this process on-line does not require substantial capital investment, since it can be set up in any autogenous process equipment arrangement. I shall emphasize that the adoption of autogenous processes is a very promising direction to take in technical rehabilitation of this industry. In combination with technical solutions developed at the Institute of Metallurgy, it will make it possible to set up no-waste copper smelting production in the Urals.

Utilization of pyrite cinders can become another reserve potential for increasing efficiency of utilization of natural resources. In addition to iron, they contain nonferrous and noble metals in quantities of commercial interest. Our institute has proposed a promising process for recovering them as separate products. This process can be carried out on standard equipment, with less capital and operating expenditures than with other known processes.

We should mention that more than 15 years ago scientists at Ural institutes substantiated the thesis of the feasibility of comprehensive processing of pyrite concentrates without producing pyrite cinders. The process includes smelting pyrite concentrates with oxygen (or industrial-grade oxygen) enriched blast, producing a refined oxide melt suitable for the cement industry and ferrous metallurgy.

Adoption of this process makes it possible at lesser cost to recover the same quantity of valuable constituents as with the existing arrangement (roasting pyrite concentrates in a fluidized bed -- processing of pyrite cinders). This produces considerable savings.

We feel that it is advisable in these next few years to test and bring on-stream a technology for comprehensive processing of pyrite concentrates: in addition to this, enterprises of the Ministry of Mineral Fertilizer Production must adopt a process for the comprehensive treatment of pyrite cinders.

The difficulties connected with setting up comprehensive processing of raw materials at existing enterprises with an established, thoroughly developed production process are understandable.

During the years of industrialization, war and postwar economic recovery the task was to achieve maximum increase in pig iron and steel production. Under those circumstances it was necessary to sacrifice recovery of iron-accompanying constitutents.

Today it is no easy matter to surmount the technological obstacle, as well as the psychological barrier, and to set up recovery of nonferrous metals at ferrous metallurgical enterprises. The problem is unquestionably solvable, however, especially if the new process is made to fit into the existing equipment setup. This was the way it was with organization of comprehensive processing of the Kachkanar titanomagnetites; their metallurgical processing is accomplished in traditional metallurgical equipment -- blast furnaces.

It is a more complicated matter to incorporate arrangements based on fundamentally new techniques which require the development and installation of new equipment. In particular, in the opinion of experts, extensive processing of complex crude iron ore with elevated titanium content is possible on the basis of methods not employing blast furnaces. They have not yet been extensively adopted in the ferrous metallurgical industry. In such instances the "birth" of a new technology involves certain capital outlays and therefore is usually indefinitely postponed, while even the roughest economic estimates attest to its unquestioned effectiveness.

Development (and consequently adoption as well) of such a process is also delayed to a considerable degree by the fact that the developing institutes lack experimental facilities. The laboratory level of industrial process development does not satisfy practical metallurgists, evoking a guarded, distrustful attitute toward the proposals of research scientists.

As practical experience attests, experimental facilities in any form -- special design offices, experimental plants, scientific-production associations -- greatly speed up the practical adoption of scientific research results. The activities of the Tulachermet Scientific-Production Association are an example of this.

The scientific-research institutes of the Ural region need to build metallurgical experimental facilities for the experimental commercial-scale testing of new processes, especially in the area of comprehensive processing of raw materials. One possibility is establishment of such a facility at one of the old Ural plants. No final decision has yet been made, however.

In this article we have mentioned only a few aspects of the problem of comprehensive processing of natural resources in the Urals. They are important, and their resolution would make it possible to increase to a substantial degree the effectiveness of utilization of mined ores. A determining role should be played by unification of the efforts of research and design institutes as well as industrial enterprises of ministries and agencies, coordinated by the USSR State Committee for Science and Technology and USSR Gosplan.

3024
CSO: 1842/62

ARTICLE DISCUSSES OVEREXPENDITURES OF METALS, FUELS, POWER AT PLANTS

Moscow EKONOMICHESKAYA GAZETA in Russian No 5, Dec 82 p 15

[Article, published under the heading "For Economy and Thrift," by V. Lisitsyn, correspondent for the republic newspaper BAKINSKIY RABOCHIY, Baku: "What Is Causing Losses?"]

> [Text] This question should be of particular interest to the workforce at the Azerbaijan Tube Rolling Plant, for this enterprise is doing a poor job with economy of resources.

This year the workforce at the Azerbaijan Tube Rolling Plant allowed an overconsumption of metal, fuel, oxygen, and electric power. What is the reason for these losses?

Here are some typical examples. Organization of major overhaul of tube-rolling mills is a serious matter. Those personnel involved in rolling-mill repair and overhaul always pledge to complete all work ahead of schedule and with excellent quality. And indeed, this powerful equipment comes back on-line ahead of schedule. In short, the first part of the pledge is observed. What about the second part? Within the first few days of operation of a major-overhauled mill, it is discovered that shafts are "flapping" and reduction gears are operating poorly. Additional work and reworking begins -- a repeat setup. The initial time gain diminishes before one's eyes, and finally disappears entirely. Time losses result in production losses. But that is not all: in bringing a mill up to normal operating conditions, hundreds of tons of reject pipe and tube come off the mill every shift.

There are also other sources of metal losses here in the tube-rolling shop. According to current standards, a ton of metal should be worked by three mandrels. In actual fact consumption is double. One of the reasons is the poor quality of the rolling-mill tooling. For a number of years now the mandrels in the shop have been cooled at a pressure considerably below that required. This naturally has an effect on their resistance to wear and leads to metal losses. This would not seem to be such an unsolvable problem -- just boost pressure in the coolant line. Particularly since there are more than 130 engineers and technicians in the shop. The fact is, however, that the mandrel problem continues to be merely discussed, but nothing has actually been done.

They speak with pride in the rolling shop about shift foremen M. Amirov and M. Abramyan -- leaders in the socialist competition for economy. The workforces they lead have achieved impressive results in reducing figures on consumption of metal and fuel per unit of output. On the whole, however, more than 3400 tons of metal have been expended above standard in this shop since the beginning of the year, and production cost has exceeded the plan-targeted figure by 1,374,000 rubles. Half of the 2700 tons of fuel overconsumption could have been saved if the gas service lines were in proper repair. They have been talking about this at the plant for a long time. But once again -- they have merely been talking. The experience of the performance leaders has not yet become that of the entire workforce, and yet 460 tons of metal has been saved since the beginning of the year just on the 700 mill.

The state of affairs in the open-hearth shop merits special discussion. In the first 9 months of the year the shop has had an overconsumption of 9000 tons of steelmaking pig iron, more than 4000 tons of metal charge, and a large quantity of addition agents. The open-hearth shop is tied up in a tight knot of difficult problems, solution of which requires prompt intervention and guidance by the enterprise and the ministry. The problem of pig iron and metal charge supply is very critical -- supply interruptions have become chronic. The steelmakers also have many complaints about the quality of the received raw materials.

But there are also problems in the open-hearth shop which are of a purely internal nature. The ingot molds must be replaced before completing the prescribed number of pours. From time to time the steelmakers complain about the plant foundry section, where these molds are made, for the poor quality of their work. The foundry workers argue back that the ingot molds become unusable because the steelmakers themselves do not treat them properly. This is a long-standing dispute. But it does not help things: the service life of ingot molds is half the prescribed figure. And they are also in short supply. And yet the foundry section which makes these molds has sufficient output capacity. The section is designed to produce 17,000 tons of castings. In the first nine months of this year they cast fewer than 200 ingot molds. This figures out to only 900 tons....

In the open-hearth shop steelmaker A. Suleymanov, deputy to the republic Supreme Soviet, initiated a movement to turn out a melt a month with economized pig iron. But this initiative has not been widely supported.

If one is to believe the reports and figures, dozens of brigades are working under the slogan "Every melt precisely as ordered!" In reality, however, one out of every three melts is at variance with the ordered grade of steel....

It would be incorrect to state that no conclusions are being drawn at the plant from all this. Conclusions are being drawn, and a number of measures have been specified, implementation of which could correct the situation. But the situation at the enterprise is changing very slowly.

Of course there are problems the solution of which is independent of the enterprise. Sometimes they mention, for example, a long-standing dispute with the ministry.

It is essentially based on the fact that in the past polyethylene nipples were placed on the ends of pipe shipped to the northern areas in order to prevent thread damage during handling operations. Then came an order from the USSR Ministry of Ferrous Metallurgy to replace the polyethylene nipples with metal ones. The order said nothing about where this metal was to be obtained. And according to the calculations of specialists at the plant, from 8 to 10 thousand tons of steel are consumed for this each year. Correspondence between the plant and the ministry on this matter has been going on for quite some time, but without result. Is this lack of clarity doing harm to the plant's workforce? Of course it is. But the tube-rolling workers are equally harmed by their own errors -- organizational and technical.

The system of material and moral incentive operating at the plant exerts little effect on achieving metal savings. Essentially nobody is made liable for overconsumption of metals. An analysis of losses due to production rejects is conducted only sporadically. Advanced technology and new equipment are slow to be adopted.

The management of this enterprise should focus attention on precisely these items in order to improve utilization of resources.

3024
CSO: 1842/61

NEW TECHNOLOGIES IN METAL PROCESSING BEING DEVELOPED

Kiev PRAVDA UKRAINY in Russian 14 Dec 82 p 2

[Article by V. Trefilov, Academician of the UkSSR Academy of Sciences, vice-president of the UkSSR Academy of Sciences, director of the Institute of Material Science Problems, UkSSR Academy of Sciences]

[Text] Among the very important problems being solved by scientists in collaboration with industry are the creation and introduction into practice of new metallic and other materials with given, at times unique properties, the development of progressive technologies of metal production, its processing and the manufacture of articles of modern technology.

Now the requirement on metallurgists which has existed for a long time--to produce more metal--has inexorably been replaced by a new requirement--not only more, but better, says Viktor Ivanovich. In other words, questions of the quality of metal have come to the foreground, and this has found reflection in the decisions of the 26th CPSU Congress and the November 1982 Plenum of the CPSU CC. In that complex of problems are inseparably interwoven the problems of producing new materials, their processing and use, the creation of low- and without-waste technologies assuring economical expenditure of energy and material and labor resources.

Large and responsible tasks have been set before science in connection with this. They were developed and made concrete on the scales of our republic at the November 1982 Plenum of the CP Ukraine Central Committee. Science can successfully solve them only in the presence of serious work done in anticipation of the following years, in the area of both basic and applied research. And on the creation of such work, its constant implementation, on the practical realization of scientific and technical ideas on that work in industry, the UkSSR Academy of Sciences concerns itself.

For example, the basic research done by scientists of the institutes of electric welding, problems of casting, problems of material science have led to the birth of new grades of high-strength steels intended for use in various branches of industry. This, in particular, applies to cold-resistant high-strength steels, great interest toward which has been manifested in the USSR Ministry of Oil and Gas Construction and the USSR Ministry of Gas Industry, since such materials have to seriously increase the reliability of main pipelines. There are also steels and alloys with special properties--these and other specific technical tasks--which must not only cause the creation of highly effective technology and guarantee the reduction of the material capacity of machines and mechanisms.

The more intensive development of the "fourth limit" (progressive methods of thermal processing of rolled metal) must contribute to the solution of such a complex task; it substantially increases its strength and other characteristics, energetic expansion of production and the application of economic profiles with "minus" tolerances, the wide use of high-strength cast-iron proposed by scientists of our Academy of Sciences, instead of castings of non-ferrous metals, and also the application of various inorganic materials--basalt fibers, stone castings, ceramics, etc. All the more importance is acquired by composite materials. An important role is played by progressive, technological processes of powder metallurgy.

I would like to especially emphasize that elevating the technical level of both ferrous and non-ferrous metallurgy is inseparably linked with the development of metallurgical machine buiilding. In that area serious attention must be given to the creation of a more effective technology and equipment for metallurgists, so that they can not only assure plan indicators of production but also obtain reserve capacities on which it is possible and necessary to conduct pilot plant "rolling" of new technologies and technology--those which will be necessary tomorrow and the day after tomorrow.

2174
CSO: 1842/64

UDC: 546.221'56'47+546.231'56'47

STATE DIAGRAMS OF $Cu_{2-x}S$-ZnS and $Cu_{2-x}Se$-ZnSe

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian Vol 18, No 11, Nov 82 (manuscript received 1 Oct 81) pp 1792-1794

MIZETSKAYA, I. B., OLEYNIK, G. S. and TRISHCHUK, L. I., Institute of Semi-Conductors, Ukrainian Academy of Sciences

[Abstract] The systems $Cu_{2-x}S$-ZnS and $Cu_{2-x}Se$-ZnSe were studied by differential-thermal and microstructural analysis. Differential-thermal analysis was performed in evacuated Stepanov vessels, specimen weight 5 g. Heating and cooling curves were recorded at 5 to 8°C/min. State diagrams of the systems are presented and are peritectic with limited solid state solubility. The limits of existence of solid solutions are 42 and 55 mol.% of zinc chalcogenides at 1185 and 1142°C, respectively, for sulfur and selenium. The copper sulfoselenides can be used as solvents in the production of zinc sulfoselenide single crystals from solutions in a melt. Figures 2; references 12: all Russian.
[42-6508]

UDC: 546.231'57'47+546.231'57'48

PHASE EQUILIBRIA IN Ag_2Se-ZnSe and Ag_2Se-CdSe

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian Vol 18, No 11, Nov 82 (manuscript received 18 Nov 81) pp 1795-1797

TRISHCHUK, L. I., OLEYNIK, G. S. and MIZETSKAYA, I. B., Institute of Semi-Conductors, Ukrainian Academy of Sciences

[Abstract] A study is presented of phase equilibria in the systems Ag_2Se-ZnSe and Ag_2Se-CdSe. Differential-thermal analysis and microstructural analysis were used to construct the state diagrams of the systems. Ag_2Se-ZnSe is a eutectic type system with limited solubility in the solid state, with the eutectic point at 13.5 mole.% ZnSe and 850°C. The Ag_2Se-CdSe diagram is a peritectic type diagram with limited solid state solubility,

with the peritectic conversion point at 62 mol.% CdSe and 970°C. Ag_2Se-based solid solutions are found in the 0 to 68 mol.% CdSe concentration interval. The solubility in the solid state drops greatly with decreasing temperature in both systems. The compound Ag_2Se can be used as a solvent for growing ZnSe and CdSe single crystals from solution in a melt.
Figures 2; references 4: all Russian.
[42-6508]

UDC: 548.33:539.26

POLYMORPHOUS CONVERSION OF GRAPHITE-LIKE BORON NITRIDE OF VARYING CRYSTALLINE QUALITY AT HIGH PRESSURES

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian
Vol 18, No 11, Nov 82 (manuscript received 1 Sep 81) pp 1835-1838

KURDYUMOV, A. V., GLADKAYA, I. S., GOLUBEV, A. S., DUBITSKIY, G. A., SLEYEAREV, V. N., OLEYNIK, G. S. and OSTROVSKAYA, N. F., Institute of High Pressure Physics, USSR Academy of Sciences; Institute of Materials Science Problems, Ukrainian Academy of Sciences

[Abstract] For the first time a systematic structural study was made of the polymorphous conversion of BN_g of varying degrees of crystalline perfection under the influence of high pressure at temperatures from room temperature to 1200°C. BN_g was compressed in a toroidal high pressure chamber at about 11 GPa. Holding time at high pressure at the test temperature was about 1 minute, and heating and cooling were carried out at 400°C/min. The phase composition of the specimens and their fine crystalline structure were studied by x-ray diffraction and transmission electron microscopy and by electron microfractography using replicas. It is shown that the mechanism of polymorphous conversion of the material at high pressures, as well as its rate and type of BN modification formed are determined by the degree of perfection of the initial crystalline structure. A three-dimensional ordered BN_g structure undergoes a martensite conversion, forming a Wurtzite modification under the experimental conditions studied. Under the same conditions, turbostrate BN_g characteristically undergoes diffusion conversion, forming a sphalerite phase. Compression of partially ordered BN_g results in both polymorphous conversion mechanisms. Figures 2; references 5: 4 Russian, 1 Western.
[42-6508]

UDC: 620.226.29

CREEP AND LONG-TERM STRENGTH OF 5VMTs ALLOY CLAD WITH VN7 ALLOY

Kiev PROBLEMY PROCHNOSTI in Russian No 10, Oct 82
(manuscript received 1 Jul 81) pp 85-89

TSVILYUK, I. S. and PYL'NIKOV, V. I., Institute of Strength Problems, Ukrainian Academy of Sciences, Kiev, Moscow

[Abstract] Results are presented from studies of creep, short-term and long-term strength of a clad VN7-5VMTs-VN7 sheet, as well as comparative data on the characteristics of the sheet and 5VMTs niobium alloy. The clad sheet was prepared by manufacture of the 5VMTs sheet 35 mm thick and VN7 sheets 3.5 mm thick, soldering of the sandwich through an interlayer of titanium 0.3 to 0.5 mm thick, hot rolling from 42 to 10 mm in steel shells at a starting temperature of 1100°C, removal of the steel shell by etching in H_2O:HNO_3:HF=1:1:1 at 70°C, annealing at 1050°C in a vacuum of $1 \cdot 10^{-2}$ Pa for 1.5 hours, subsequent rolling to 1 mm thickness with intermediate annealing. It is found that the sandwich has advantages in short-term properties over 5 VMTs at up to 1300°C, but is significantly inferior in long-term strength at 1000 to 1400°C. Figures 5; references 4: all Russian. [38-6508]

STATISTICAL STUDY OF ELECTRODE SHORT CIRCUIT DISTRIBUTION FOLLOWING SINGLE PULSED DISCHARGE

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 5, Sep-Oct 82
(manuscript received 15 Sep 81) pp 25-29

ORLOV, A. G., Moscow

[Abstract] Experiments involving counting of the relative frequency of short circuits at various moments in time after beginning of a single current pulse were used to determine the time characteristics of the distribution of short circuits in a time segment not exceeding the pulse repetition period. Studies were performed by a method of grouped individual discharges and rapid pumping of a dielectric fluid through the installation. This eliminated the interaction of discharges and broke up stable shorts resulting from a previous discharge. Breakdown voltages and separation distances did not vary by more than 5%. After a discharge channel was formed the high voltage power supply was disconnected by semiconductor switches and the assigned discharge current was maintained for the assigned time. The installation allowed detection of short circuits both during the pulse and in the pause between pulses. During a time not exceeding the pulse repetition period the formation of short circuits results from expulsion of melted metal from a hole. The probability of development of a short dircuit greatly increases on the trailing edge of a rectangular current pulse and is determined largely by the working fluid

circulation. The probability of development of a short circuit on the trailing edge of a current pulse is independent of its length and depends essentially on pulse amplitude. For some materials, short circuits may develop during the current pulse. The nature of expulsion of metal from a hole depends on temperature conditions for each pair of electrodes. Figures 4; references 4: 3 Russian, 1 Western.
[34-6508]

UDC: 620.186.84:539.377

CRITICAL GRAIN SIZE CORRESPONDING TO SUPERPLASTIC FLOW TRANSITION

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 43, No 3, Sep 82 (manuscript received 27 Apr 81; in final form 22 Oct 81) pp 604-606

VALIYEV, R. Z., YEMALETDINOV, A. K. and KAYBYUSHEV, O. A., Ufa Aviation Institute imeni Ordzhonikidze

[Abstract] Based on present day concepts of the mechanism of deformation, the value of critical grain size d_c resulting in the transition to superplastic flow is estimated. During superplastic deformation the primary mechanism is grain boundary slipping, altering the transmission of deformation from grain to grain. The movement of grain boundary dislocations must be considered the microscopic mechanism of grain boundary slipping. The value of d_c is estimated for an alloy of Zn plus 0.4% Al. The calculated and experimental values of d_c agree, confirming the correctness of the approach to analysis of d_c based on the idea of changing mechanism of deformation of a polycrystal with decreasing grain size. Figures 1; references 11: 7 Russian, 4 Western.
[35-6508]

UDC: 669.053.2.001

NEW METALLURGICAL PROCESSES BASED ON HIGH SPEED CRYSTALLIZATION AND DIFFUSION OF METALS

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 6, Nov-Dec 82 (manuscript received 3 Jul 82) pp 11-20

BELOV, A. F., Moscow

[Abstract] Several metallurgical processes developed over the past 15 years are described, with the common feature that they all involve very rapid crystallization of very small droplets of metal. Processes described include granular metallurgy of heat resistant nickel and titanium alloys; crystallization of aluminum alloys at cooling rates of 10^3-10^4°C/sec;

crystallization of aluminum alloys at over 10^6°C/sec; and hot isostatic pressing as a means of healing defects in metals. A diagram is presented of a process of diffusion welding of a complex blank and the structure of welded joints of titanium alloy and nickel alloy is illustrated. Figures 3; references 4: all Russian.
[52-6508]

UDC: 669.85/86:535.33/34

INTERPRETATION OF $N_{4,5}$ THRESHOLD POTENTIAL SPECTRA OF RARE EARTH METALS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 54, No 4, Oct 82 (manuscript received 14 Jul 81; in final version 9 Mar 82) pp 808-810

BOROVSKIY, I. B., KOMAROV, Ye. Ya., PETRENKO, N. M. and TSOY, N. P., Institute of Solid State Physics, USSR Academy of Sciences

[Abstract] An equation is presented for the interpretation of the threshold potential spectra of the normal and transition three-d metals. An attempt is made to substitute the inelastic scattering coefficients of electrons obtained from the $N_{4,5}$ characteristic loss spectra in the equations. The results of computations in which the inelastic scattering coefficients are replaced by reflected electron energies for La and Ce are compared with experimental values, indicating that the curves still coincide poorly with each other. Figures 2; references 13: 3 Russian, 10 Western.
[51-6508]

UDC: 669.85/86:535.33/34

COMPARISON OF $N_{4,5}$ SPECTRA OF CHARACTERISTIC LOSSES AND ABSORPTION SPECTRA OF RARE EARTH METALS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 54, No 4, Oct 82 (manuscript received 14 Jul 81) pp 806-807

KOMAROV, Ye. Ya. and BOROVSKIY, I. B., Institute of Solid State Physics, USSR Academy of Sciences

[Abstract] A study was made of the energy distribution of electrons which have lost energy in excitation of ionization of $N_{4,5}$ rare earth metal atoms when a monochromatic beam of electrons strikes the surface of a solid specimen. These characteristic loss spectra are divided into reflection and transmission spectra for polished metal plates about 0.8 mm thick made from massive REM specimens in which the content of foreign impurities is not over 0.25%. The Born approximation for single inelastic scattering of electrons with energy E_p=900 eV does not converge with the dipole approximation, meaning that the results observed cannot be explained by single

inelastic scattering of electrons at high angles. Assumption of single or multiple elastic scattering can make the results correspond more precisely with experimental results. Figures 1; references 8: 4 Russian, 4 Western. [51-6508]

UDC: 539.216:539.213

STRUCTURE OF THERMALLY ATOMIZED WO_3 FILMS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 267, No 3, Nov 82 (manuscript received 7 Jun 82) pp 596-598

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[Abstract] As a result of the great interest in amorphous transition metal oxide films for use in microelectronics, a study was made of an oxide produced by thermal evaporation of WO_3 powder in a vacuum with precipitation onto glass substrates. Measurements of X radiation scattered by the objects were performed on a diffractometer. The results indicate that the WO_3 oxides studied are quasi-amorphous, consisting of a polycrystal with very small grain diameter. The rhombic phase agrees best with the experimental data, with the slight differences observed possibly resulting from failure to consider the nature of distribution of the atoms in the intercrystalline areas and the presence of some variation of crystalline shape and size. Figures 2; references 9: 4 Russian, 5 Western.
[41-6508]

UDC: 539.388.1

TEMPERATURE-STRESS VARIATION OF HEAT RESISTANT ALLOY CYCLIC CREEP ACTIVATION ENERGY

Kiev PROBLEMY PROCHNOSTI in Russian No 11, Nov 82 (manuscript received 2 Feb 81) pp 38-45

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[Abstract] The activation energy of the process of cyclic creep of heat resistant nickel alloys upon multicycle loading is determined and the influence of temperature and cycle stresses on it is estimated. These data are significant for understanding of the microscopic mechanism of the cyclic creep process and reveal the effect of changes in stress and temperature on the creep rate. Cyclic creep was studied in a homogeneous stress state with asymmetrical extension and compression and under mild loading conditions on smooth cylindrical specimens with a gage section diameter of 7.5 mm and a

length of 5 times the gage diameter. It is found that in the creep rate interval of 10^{-3} to 10% per hour the degree of plastic deformation which has occurred and the cyclical component have practically no influence on the cyclic creep activation energy of the alloys studied. As the static component increases the activation energy of the alloys studied. As the static component increases the activation energy decreases slightly; as temperature increases it increases slightly. In general the activation energy of high temperature cyclic creep of these alloys is comparatively independent of cycle stress and temperature and the asymmetrical cycle stress influences the creep rate by changing the frequency factor. The cyclic creep mechanism is based on shifting of dislocations, which is indicated by the presence of a clear stage of stable creep and the fact that in heat resistant nickel alloys transverse slipping is quite difficult. Figures 4; references 18: all Russian.
[45-6508]

UDC: 669.017:539.52(438)

BAROPLASTIC EFFECT IN SUPERPLASTICITY

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 267, No 2, Nov 82 (manuscript received 19 May 82) pp 37 -372

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[Abstract] A study is presented of the influence of high hydrostatic alloy Zn+0.4% Al with ultrafine grain structure (d~1μm). Cylindrical specimens 3 mm in diameter with 2 mm gage section length were tested in extension at deformation rates of 10^{-4} to $10^{-1}s^{-1}$ (room temperature) at 0.1 MPa and 1 GPa with the specimens in gasoline containing up to 20% oil. The studies revealed a baroplastic effect. Further development of the studies could facilitate a deeper understanding of the physical nature of superplasticity and determination of the role played by such processes as diffusion creep and pore formation. Figures 2; references 13: 10 Russian, 3 Western.
[46-6508]

UDC: 621.763

CONTACT STRESSES AND FORCE PARAMETERS IN ROLLING BOROALUMINUM SHEETS PARALLEL TO REINFORCING FIBERS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 6, Nov-Dec 82 (manuscript received 26 Jan 81) pp 56-61

AREF'YEV, B. A., PISKAREV, V. D., POPOV, V. I., MALASHENKOV, S. G., LOKTIONOV, G. I. nad SYAMINULIN, Z. S., Moscow

[Abstract] A study is presented of the results of an experimental investigation of contact stresses and force parameters during rolling of broad boroaluminum sheets in parallel to the direction of the reinforcing fibers. When this material is produced by rolling layers of the two materials deformation occurs by reducing the thickness and compacting the pore structure of the blank. For this reason the material in the literature on rolling of porous materials is basically inapplicable to this process. The results presented allow estimation of some of the specific features of the influence of the packet sturcture on contact stresses, total pressure of the metal on the rolls and rolling torque. The contact stresses andfforce parameters basically depend on the total degree of deformation in each pass. When specimens with fiber diameter 100 μm are rolled the force parameters are 1.5 to 2 times as great as when blanks with 140 μm diameter fibers are rolled. An anomalously long zone of deformation is observed in the last passes, primarily due to an increase in the lead zone. A deformation focus model is produced which indicates that this is caused by the elastic aftereffect of the reinforcing fibers, stretched in the entry to the focus of deformation. Figures 3; references 3: all Russian.
[54-6508]

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